Marconi
Instruments

V.H.F. SWEEP UNIT

TM 9693

MP MASTER
MA23735

Instruction Manual

No. EB 9693

for

V.H.F. Sweep Unit

TM 9693

mi

Technical Publications

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MARCONI INSTRUMENTS LIMITED

ST. ALBANS HERTFORDSHIRE ENGLAND

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Chapter 1

General information

1.1 INTRODUCTION

The TM 9693 V.H.F. Sweep Unit operates in conjunction with the TF 2361 Sweep Generator and the TM 9695 Attenuator, the three units together forming a general-purpose instrument suitable for many applications in testing v.h.f. frequency responses.

The sweep unit fits into the attenuator framework, on the left-hand side of the attenuator, and the framework then fits into the recess at the top of the sweep generator. The sweep unit receives power supplies and control signals from the sweep generator via a 24-way connector. Full details of the sweep generator are contained in its instruction manual, EB 2361.

The v.h.f. sweep unit produces an output frequency variable from 1 MHz to 300 MHz, the variation being controlled by a sweep voltage from the main unit. The sweep can be centred at any point in the frequency range, and the sweep width can be varied from zero to the maximum available on either side of the centre frequency.

Marker generators can be switched on to provide a marker at every 1 MHz, 10 MHz or 100 MHz interval. Different markers may be displayed on alternate traces, and external markers can be used either alone or in conjunction with the internal markers.

Additional features include a linear or semi-log sweep facility, internal or external a.l.c., wide or narrow sweep width and 61 dB output attenuation available in 1 dB steps.

The instrument can be set to any of the operational modes selected by a front panel function switch on the main unit. This gives a range of internal sweep drive from 0.01 Hz to 100 Hz in four decades, mains lock to mains frequencies from 45 to 400 Hz, TV lock to frame scan on 405, 525 or 625 line composite television signals, external control by signals from d.c. to 20 kHz, a c.w. mode in which the unit behaves as an ordinary signal generator, and a manual mode in which a manual rate control is used to manually sweep over the range of frequencies set up on the v.h.f. sweep unit. The ratio of sweep to flyback can be set at 10:1 or 1:1, and on the internal sweep ranges the instrument can be set to give a single sweep when a switch is operated.

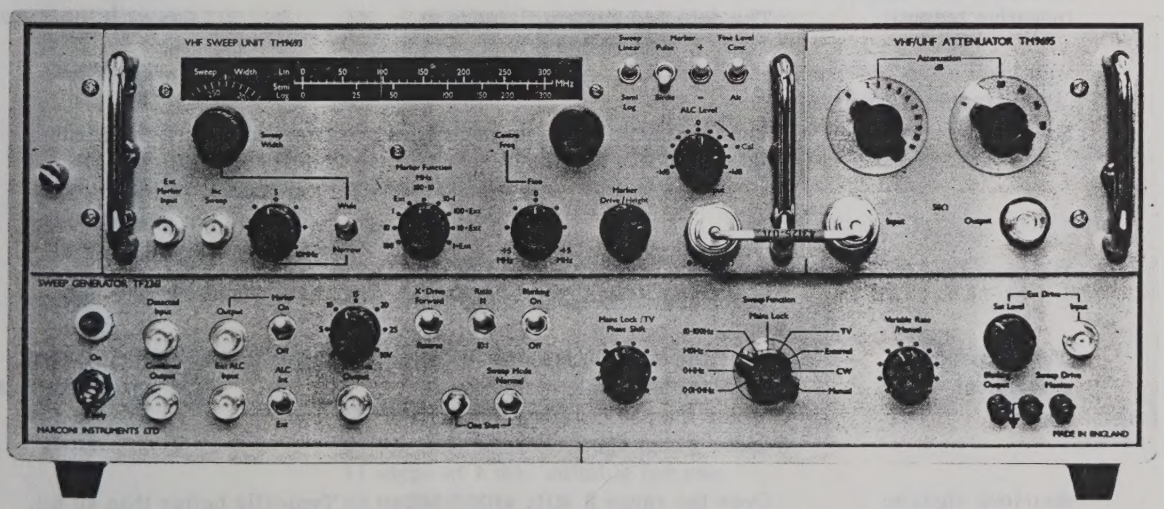


Fig. 1.1 VHF sweep unit TM 9693 and attenuator TM 9695 fitted in sweep generator unit TF 2361

1.2 DATA SUMMARY

Characteristics	*Performance*	*Supplementary information*
General characteristics		
Frequency range:	1 MHz to 300 MHz in one band.	
Output level at +1 dB: (Calibrated)	0.5 V ±5% across 50 Ω.	
Fine level:		Provides variable shift up to ±1 dB, or variable separation of alternate traces up to ±1 dB from reference trace.
Fine level: maximum error:	±0.1 dB at ±1 dB points.	
Output impedance:		50 Ω nominal.
Output v.s.w.r. (with TM 9695):	Better than 1.25:1.	
R.F. output flatness:		The output flatness at 0 dB from 1 MHz to 300 MHz is within ±0.25 dB.
A.L.C. level adjustment:	Provides a means of resetting the internal level when using external a.l.c.	Provides uncalibrated output typically 0.75 V r.m.s. with degraded performance.
Detected system flatness with TM 9701 (negative output):	The detected system flatness at 0 dB, 1 MHz to 300 MHz is within ±0.25 dB.	
Stability:	After one hour warm up period, less than 1000 kHz/hour.	After five hours the random drift is typically ±30 kHz/ 10 minutes. Temperature coefficient not greater than 100 kHz/°C.
Residual f.m.:	Less than 3 kHz peak at 10 MHz. Less than 6 kHz peak at 300 MHz.	
Total harmonic distortion:	Over the range 3 MHz to 300 MHz the total harmonic distortion is better than 30 dB down (measured under swept operation).	Typically better than 40 dB.
Spurious signals:	Over the range 3 MHz to 300 MHz the spurious signals are better than 35 dB down (measured under swept operation).	Typically better than 40 dB.

Characteristics	Performance	Supplementary information
Sweep width		
Range:	Continuously variable from zero up to 300 MHz.	
Dial accuracy:	±5% of sweep width ±10 MHz.	
Narrow sweep width:	10 MHz nominal.	
Sweep linearity (linear mode):	The maximum ratio of any two 10 MHz intervals is not greater than 1.5:1.	The 1 MHz intervals are substantially linear in any 10 MHz interval.
Centre frequency		
Accuracy:	Linear: The frequency accuracy at every 10 MHz scale marking is within ±5 MHz. Semi-log: (a) The frequency accuracy at zero scale marking is within ±5 MHz. (b) The frequency accuracy at 300 MHz scale marking is within ±30 MHz.	
Fine control:	Provides a nominal frequency shift of ±1.5 MHz.	
Incremental sweep		
Description:		Sweep and c.w. functions modulated by an external c.w. input.
Input frequency range:	d.c. to 20 kHz.	
Max. input level:		50 V peak.
Sensitivity:	200 kHz/V nominal at 1 kHz.	
Attenuator TM 9695		
Range:	61 dB in 5 steps of 10 dB and 11 steps of 1 dB, suitable for use up to 1000 MHz.	
Accuracy:	±1% of attenuator reading ±0.2 dB up to 1000 MHz.	

Characteristics	Performance	Supplementary information
Flatness:	At any attenuated level, the output flatness from 1 MHz to 300 MHz is within ±0.25 dB ±0.2% of attenuator reading.	

Markers

Form:		1, 10, 100 MHz markers derived from internal crystal controlled oscillators. May be displayed as birdie or pulse markers separately or in combinations with each other or with external markers.
Amplitude:	Common control variable up to at least: (a) Birdie: 1.0 V p-p (all functions) (b) Pulse: 15 V peak (all functions)	
Marker drive control:	Adjustable for optimum marker display.	
Ext. marker input:	Requires an input of at least 100 mV r.m.s. to produce a satisfactory marker display.	

Power supplies +24 V, -24 V and +110 V d.c. supplies obtained from main unit TF 2361.

Dimensions and weight

	Height	Width	Depth	Weight
TM 9693:	3.75 in (9.5 cm)	10.5 in (26.6 cm)	13.5 in (34.3 cm)	9.5 lb (4.3 kg)
TM 9693 with TM 9695:	3.75 in (9.5 cm)	16.5 in (42 cm)	13.5 in (34.3 cm)	14.75 lb (6.7 kg)

1.3 ACCESSORIES

Accessories supplied with TM 9695

	Description	M.I. code
①	VHF/UHF Detector TM 9701	46838-011
	For displaying the output from the sweep generator or from the unit under test. Positive and negative half-wave 50 Ω outputs. Includes :	
②	50 Ω Termination	23443-789
	Kit, comprising :	46883-063
	Connecting Link	43125-071
	For connecting the sweep unit output to the attenuator input.	
	Free Plug type N 50 Ω	23443-705
	Adapter type N male to male 50 Ω	23443-781
	Accessory Case TM 9936	41674-031

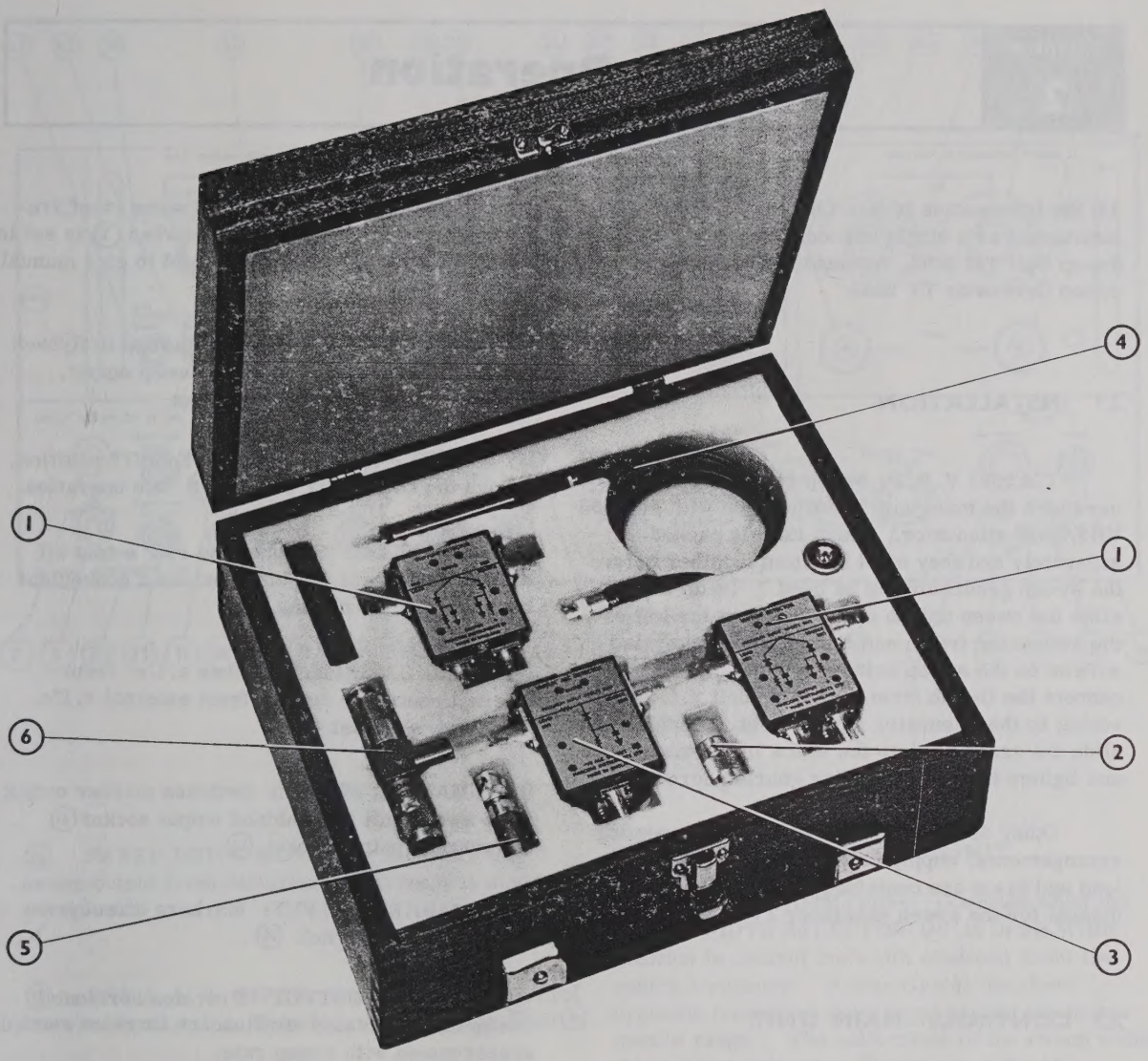


Fig. 1.2 A selection of accessories

Optional accessories

	Description	M.I. code
③	VHF/UHF ALC Detector TM 9702 For remote levelling of the sweep generator. Negative half-wave 50 Ω output, v.s.w.r. 1.05:1.	46838-012
④	VHF/UHF Probe Detector TM 9650 0.5 in (127 mm) diameter probe giving a half-wave negative output. Input capacitance to earth approximately 2 pF. Includes :	44416-077
	Accessory Kit TM 9737	46883-029
⑤	BNC Adapter For connecting TM 9650 to a type BNC socket	23443-801
⑥	T-Connector TM 7948 For connecting TM 9650 to a type N plug and a type N socket.	43167-007
	100:1 Multiplier TM 7947 For attaching to the end of TM 9650	44416-050

Chapter 2

Operation

All the information in this Chapter refers to the instrument as a single unit comprising the V. H. F. Sweep Unit TM 9693, Attenuator TM 9695 and Sweep Generator TF 2361.

2.1 INSTALLATION

TM 9693 V. H. F. Sweep Unit can only be used with the main unit in conjunction with TM 9695 VHF/UHF attenuator. Each item is packed separately and they must be fitted together before the sweep generator can be used. To do this, slide the sweep unit in to the space on the left of the attenuator frame and tighten the two knurled screws on the sweep unit front panel. Then, connect the U-link from the sweep unit r. f. output socket to the attenuator input socket. Finally slide the assembly into the space in the main unit and tighten the two remaining knurled screws.

Other details of installation, rack mounting arrangements, supply voltage adjustment, mains lead and fuses are contained in the instruction manual for the sweep generator TF 2361.

2.2 CONTROLS—MAIN UNIT

① SUPPLY: A. C. mains on/off switch.

② SUPPLY INDICATOR LAMP: Lamp will glow when the supply is switched ON.

③ SWEEP FUNCTION: Switch for setting the sweep generator to any of the operational modes.

④ PHASE SHIFT: Varies the phase of the sweep output over a range of at least 270° with respect to the input trigger in mains lock or TV mode.

⑤ VARIABLE RATE: Gives continuous variation of sweep rate over selected range on internal sweep modes, and in mains lock and TV modes adjusts the actual sweep + flyback period over a range corresponding to a rate of 40 - 70 Hz, although the sweep repetition rate may be locked to some other frequency between 45 and 400 Hz. When ③ is set to MANUAL, this control can be used to give manual sweep.

⑥ RATIO: Selects a ratio of sweep to flyback of either 1:1 or 10:1. Affects sweep output, blanking output and X-drive output.

⑦ SWEEP MODE: In the ONE SHOT position, brings the ONE SHOT switch ㉓ into operation.

⑧ BLANKING: Switches the r. f. output off during the retrace. This provides a convenient base line for the display.

⑨ A. L. C. switch: Switches a. l. c. from internal control to control from external a. l. c. detector via socket ⑲.

⑩ MARKER SWITCH: Switches marker output from sweep unit to combined output socket ㉑ and marker output socket ⑪.

⑪ MARKER OUTPUT: Markers direct from sweep unit, via switch ⑩.

⑫ X-DRIVE OUTPUT: Provides horizontal sweep for associated oscilloscope or chart recorder, synchronized with sweep rate.

⑬ X-DRIVE LEVEL CONTROL: Sets X-drive output level from 0 to 30 V p-p into 50 kΩ load, or from 0 to 2 V p-p into 1 kΩ load.

⑭ EXT DRIVE INPUT: An input signal from d. c. to 20 kHz will sweep the generator when the SWEEP FUNCTION switch is set to EXTERNAL.

⑮ EXT DRIVE SET LEVEL: Adjusts sensitivity of EXT DRIVE INPUT.

⑯ BLANKING OUTPUT: Square wave output of blanking generator (1:1 or 10:1 according to position of RATIO switch) of +22 V for synchronizing or triggering associated equipment. Synchronized with sweep rate.

⑰ EARTH SOCKET.

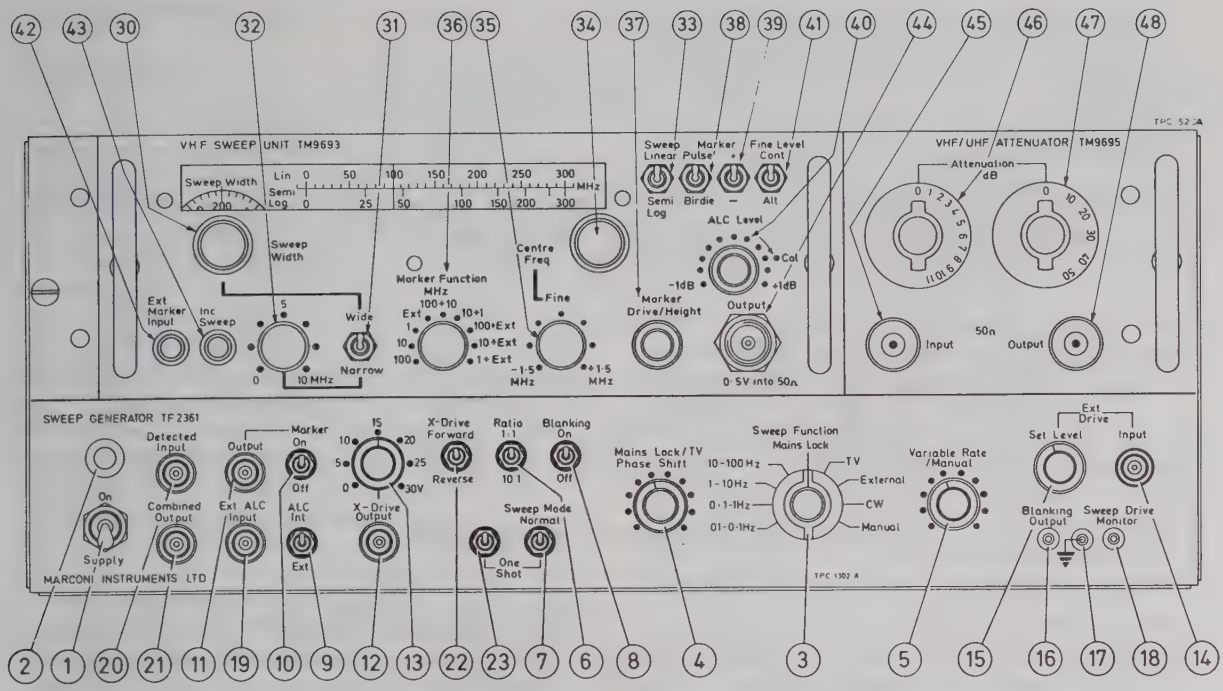


Fig. 2.1a Front panel controls and connectors

⑱ SWEEP DRIVE MONITOR: Monitors the sweep output from distorter and drive unit in v.h.f. sweep unit.

⑲ EXT A.L.C. INPUT: Automatic level control from external a.l.c. detector, via A.L.C. switch ⑨

⑳ DETECTED INPUT: Accepts input from the detector in use so that markers may be added.

㉑ COMBINED OUTPUT: Combination of detected input and markers (with MARKER switch on)

㉒ X DRIVE SWITCH: To suit the polarity requirements of an associated oscilloscope or chart recorder connected to the X-drive output, the output horizontal sweep waveform may be either positive-going when the switch is set to FORWARD, or negative-going when set to REVERSE.

㉓ ONE SHOT: Spring-loaded switch, operational with the SWEEP MODE switch in the ONE SHOT position; triggers sweep for one cycle when released.

2.3 CONTROLS — SWEEP UNIT

㉚ SWEEP WIDTH (wide): Operates when the SWEEP WIDTH SELECTOR ㉛ is in the WIDE position to control the width of sweep about the centre frequency. A mechanical interlock prevents frequency excursions beyond the instrument's range. The calibration of the sweep width dial applies only when ㉝ is set to LINEAR.

㉛ SWEEP WIDTH SELECTOR: Brings controls ㉚ wide or ㉜ (narrow) into operation.

㉜ SWEEP WIDTH (narrow): Operates when the SWEEP WIDTH SELECTOR ㉛ is in the NARROW position; gives sweep width control from 0 to 10 MHz about centre frequency set by centre frequency controls.

㉝ SWEEP LINEARITY: Selects either linear or semi-log sweep waveform.

㉞ CENTRE FREQUENCY: Varies centre point of sweep from 0 to 300 MHz, as indicated on scale visible through rectangular window.

㉟ FINE CENTRE FREQUENCY: Gives ±1.5 MHz variation about selected centre frequency.

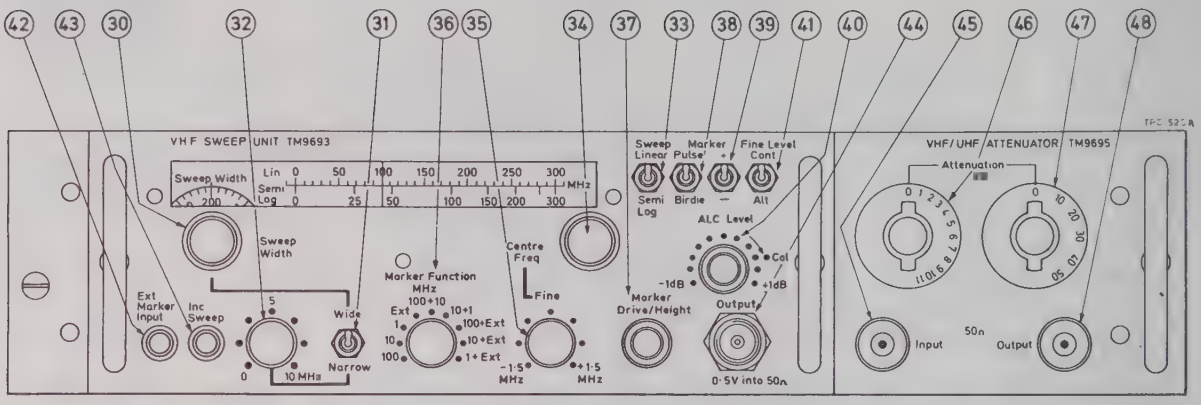


Fig. 2.1b Front panel controls and connectors

(36) MARKER FUNCTION: Gives choice of markers: internally derived at 100 MHz, 10 MHz or 1 MHz spacing, or externally derived. Combinations of markers can also be selected.

(37) MARKER DRIVE: Grey knob controls marker drive for best resolution (pulse markers).

MARKER HEIGHT: Red knob.

(38) MARKER SELECTOR: Selects birdie or pulse type internal and external markers.

(39) MARKER POLARITY: Selects positive or negative-going internal and external pulse markers.

(40) A.L.C. LEVEL : The red knob, when in the counter-clockwise unswitched range, controls the output signal between 0 and 0.75 V r.m.s. When the knob is fully clockwise switched to the CAL position, the output signal is 0.45 V r.m.s. when the FINE LEVEL control is at 0 dB and 0.5 V r.m.s. when the FINE LEVEL control is at +1 dB.

FINE LEVEL : The grey knob gives a ±1 dB variation of the output signal from a reference level set by means of the A.L.C. LEVEL control. According to the setting of the FINE LEVEL SWITCH, the variation is applied continuously or to alternate sweeps.

(41) FINE LEVEL SWITCH: In the CONTINUOUS position the fine level control is operative on every sweep. In the ALTERNATE position the fine level control is operative on every other sweep, giving a double trace display on an oscilloscope for accurate measurements.

(42) EXT MARKER INPUT: Socket taking external marker input to marker mixer circuit. Input level 100 mV r.m.s.

(43) INCREMENTAL SWEEP: Socket taking external f.m. or incremental sweep input to vary frequency. Input level of 1 V gives 200 kHz change of frequency.

(44) SWEEP UNIT OUTPUT: Output level up to 0.75 V, calibrated level 0.5 V. Normally linked to ATTENUATOR INPUT (45).

(45) ATTENUATOR INPUT: Attenuator input, normally linked to the SWEEP UNIT OUTPUT.

(46) ATTENUATION: Fine control giving 1 dB steps of output attenuation up to 11 dB.

(47) ATTENUATION: Coarse control giving 10 dB steps of output attenuation up to 50 dB.

(48) R.F. OUTPUT: Output level up to 0.75 V, calibrated level up to 0.5 V.

NOTE: To achieve the wide operational flexibility of this instrument a large number of toggle switches are provided. The normal manner of use corresponds, for each, to the up position. Until you become familiar with the function of each, or if difficulty is encountered in obtaining the expected behaviour, you are recommended to start with all toggle switches UP.

2.4 RESPONSE DISPLAY

Introduction

Many types of circuit require accurate checking and careful setting up in order to meet the required performance, and this can be a difficult and lengthy process. The sweep generator has facilities for rapid and accurate checking of such circuits as wide band amplifiers and band-pass filters.

The CENTRE FREQUENCY and SWEEP WIDTH controls can be adjusted until the response of the circuit is seen over each sweep cycle. Adjustments carried out to alter one part of the characteristic may also affect another part, and such effects can be immediately seen so that optimum adjustments can be made.

The gain of an amplifier may be measured by first displaying the unattenuated sweep directly on the oscilloscope, and then displaying it through the amplifier with sufficient attenuation to make the two displays have an identical level. The attenuation inserted is a measure of the amplifier gain.

The 3 dB points on a curve can be fixed by adding 3 dB attenuation to the displayed characteristic and noting the horizontal graticule line that passes through the peak of the curve. Remove the 3 dB attenuation, and the same graticule line will cut the curve at the 3 dB points.

Connections

To display the response characteristic of a circuit or a complete equipment within the frequency range of the v.h.f. sweep unit, a detector and a display unit, which can be either an oscilloscope or an X-Y recorder, are required.

(1) Connect the r.f. output from the sweep generator to the equipment under test and the output from this equipment to the detector.

(2) The detected output can be connected direct to the display unit but if, as is usual, markers are to be displayed, connect the detector to the DETECTED INPUT of the sweep generator and the COMBINED OUTPUT to the display unit - vertical input of an oscilloscope, Y input of an X-Y recorder.

(3) Connect the X-DRIVE of the sweep generator to the display unit - horizontal input of an oscilloscope, X input of an X-Y recorder.

Take care that r.f. connections are made with the correct impedance cable and connectors, and that proper terminating impedances are provided where necessary, since otherwise the mismatch produced can cause misleading response characteristics. The r.f. output impedance is 50 Ω.

Detectors

A V.H.F. Detector TM 9701 is supplied with the instrument; this is suitable for connection between units of a matched system (bridging measurements), or as the final item in a system when it must be fitted with an appropriate terminating impedance.

V.H.F. Probe Detector TM 9650, which is available as an optional accessory, is a high impedance probe suitable for connection to a circuit at any point, rather than one of a particular impedance. It is particularly convenient to use within a circuit because of the range of tips provided.

Note that the maximum input for either detector is 4 V r.m.s.; however if the probe detector is in use the optional accessory TM 7947

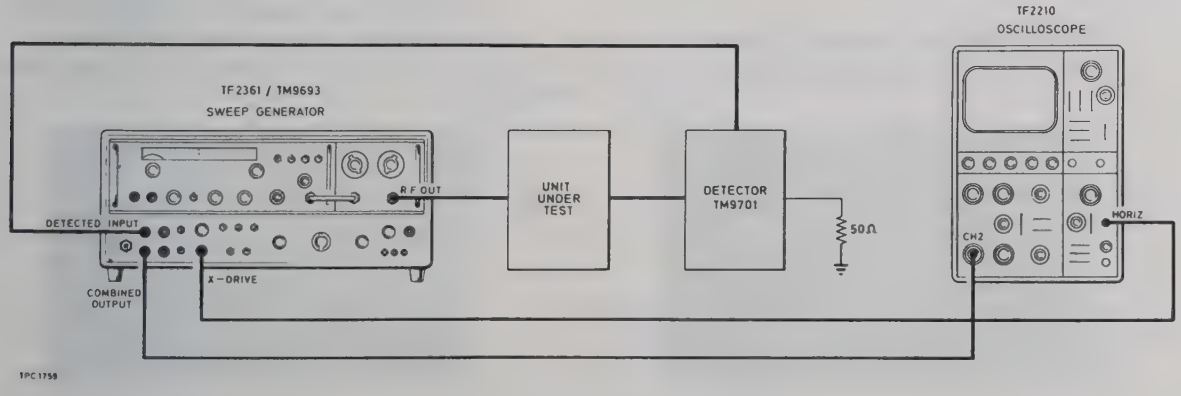


Fig. 2.2 Connections for response display

100:1 Multiplier can be fitted. This is a capacitive divider with a nominal 100:1 ratio. Its maximum input is 300 V r.m.s. up to 100 MHz; above 100 MHz the maximum r.m.s. input is

$$\frac{3 \times 10^6}{f^2} \text{ volts}$$

where f is in MHz

(V d.c. + V a.c. peak must not exceed 1000 V.)

Internal sweep

(1) Turn the SWEEP FUNCTION switch to one of the positions 0.01 - 0.1 Hz, 0.1 - 1 Hz, 1 - 10 Hz or 10 - 100 Hz according to the range in which the sweep rate is wanted to lie and make fine adjustments to the rate with the VARIABLE RATE control.

In general, select as slow a sweep rate as will allow the display to be viewed comfortably. High sweep rates must particularly be avoided if:

(a) low frequencies are being swept,
(b) the detector has a long time constant,
(c) the circuit under test has a steep slope to its characteristic, e.g. a filter or a high Q tuned circuit.

To check whether the sweep rate is too fast, turn the RATIO switch to 1:1 and the BLANKING switch to OFF. The display should then consist of identical forward and return traces exactly superimposed; if the two traces are separated the sweep rate must be reduced. The effect is shown in Figs. 2.3 and 2.4.

If an X-Y recorder is being used, a rate within the lowest range (0.01 - 0.1 Hz) will be needed, since the pen cannot slew over the chart in less than about 0.5 s.

(2) Set the SWEEP LINEARITY switch to LINEAR; normally the SEMI-LOG position is only used when close examination of the l.f. portion of the sweep is wanted.

(3) Adjust the CENTRE FREQUENCY control so that the scale indicates the frequency that is to lie at the centre of the swept band.

(4) If the swept band is to be less than 10 MHz wide, set the SWEEP WIDTH SELECTOR to NARROW and set the NARROW SWEEP WIDTH control (lower control) to the desired sweep. For wider sweeps, set the SWEEP WIDTH SELECTOR to WIDE and use the WIDE SWEEP WIDTH control to adjust the sweep width. The width is shown on the dial in the window immediately above the control.

NOTE: There is a mechanical interlock between the WIDE SWEEP WIDTH and CENTRE FREQUENCY controls to prevent the instrument being set up for a frequency excursion beyond its range.

(5) Select the ratio of sweep to flyback desired using the RATIO switch. Normally 10:1 is used, but 1:1 can be selected to give a slower flyback; useful where the detector time constant is not short compared with the flyback rate.

(6) Set the SWEEP MODE switch to NORMAL.

(7) Adjust the X-DRIVE LEVEL control and X-DRIVE switch to suit the sensitivity and polarity of the display oscilloscope or recorder.

2.5 OUTPUT

Internal A.L.C.

Set the A.L.C. switch to INTERNAL and set the A.L.C. LEVEL control fully clockwise switched to the CAL position.

A coarse and a fine step attenuator affect the output level; the total range of control is 61 dB in 1 dB steps. In addition the FINE LEVEL

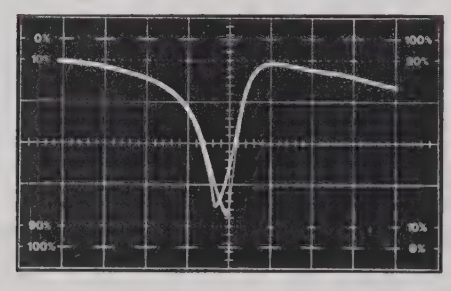


Fig.2.3 Swept display of a filter — rate too high

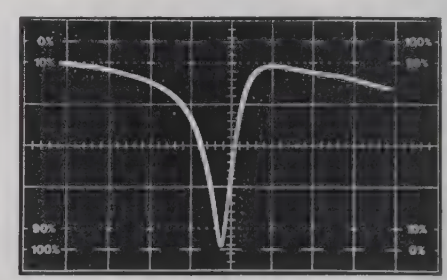


Fig.2.4 Swept display of a filter — correct rate

control provides up to ±1 dB further variation of the level. The level, in dB referred to 0.45 V, at the R.F. OUTPUT socket is thus given by the algebraic sum of the settings of the two stepped attenuators and the FINE LEVEL control. To find the output level in volts, use the decibel conversion table at the end of this chapter.

External A.L.C.

Where the equipment under test is located some distance (more than about 1 m) from the sweep generator, with a resulting loss of flatness due to the length of leads, external a.l.c. can be used with advantage to improve the flatness.

(1) Connect the V.H.F. A.L.C. Detector TM 9702 between the unit under test and the lead from the R.F. OUTPUT socket.

(2) Connect the detected output from the a.l.c. detector to the sweep generator EXTERNAL A.L.C. input.

(3) Make other connections and set the controls to display the response as described in Sect. 2.3.

(4) Set the A.L.C. switch to INTERNAL and note the position on the display of the lowest point of the response curve. Turn the A.L.C. switch to EXTERNAL and adjust the A.L.C. LEVEL control so that the lowest point on the response curve is at the position it occupied with the switch at INTERNAL.

Owing to the a.l.c. action, the source impedance is effectively zero at the diode connection point and, to make the impedance finite for matching to the load, a 50 Ω series resistor is connected. The equivalent circuit is shown in Fig. 2.6.

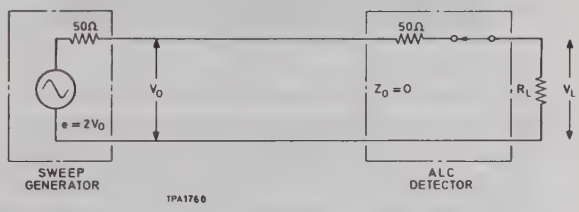


Fig. 2.6 Equivalent circuit with external a.l.c.

Because of the series resistor, the voltage developed in the load will be smaller than the sweep generator indicated output voltage. The voltage developed across the load R_L is

$$V_L = 2\,V_0 \frac{R_L}{50 + 50 + R_L} = \frac{2\,V_0}{1 + \frac{100}{R_L}}$$

where V_0 is the voltage which would be developed by the sweep generator direct into a 50 Ω load.

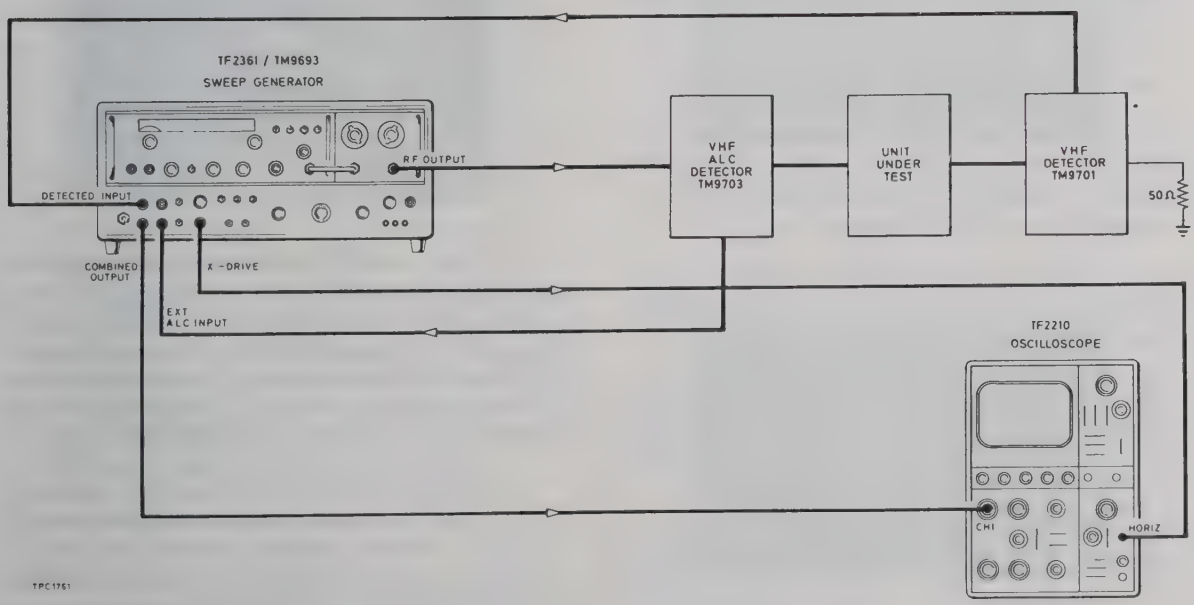


Fig. 2.5 Connections for external a.l.c.

For a matching load, $V_L = \frac{2}{3} V_O$

Since with external a.l.c. the attenuators are within the control loop they cannot be used to directly control the output level. To obtain full control of the output level without loss of performance a separate attenuator should be used between the a.l.c. detector and the unit under test. However, the internal attenuators can be used to give control of the level if the A. L. C. LEVEL control is reset, as described in step 4 above, each time the amount of attenuation is altered. The use of the attenuators in this way reduces the loop gain of the control system, but up to about 20 dB can be used before the fall-off in performance becomes noticeable.

The use of external a.l.c. also provides a way of improving the output v.s.w.r. from 1.25:1 at the attenuator to 1.05:1 at the V. H. F. A. L. C. Detector TM 9702. If then the output level is to be altered, the detector must be followed by a coaxial attenuator having a comparably low v.s.w.r.

Alternate sweep

The effect of the fine level control can be applied to every sweep or it can be confined to alternate sweeps. Which mode of operation applies is governed by the setting of the FINE LEVEL SELECTOR switch. With the FINE LEVEL SELECTOR at ALTERNATE every other sweep is changed in amplitude by an amount set up by the FINE LEVEL control; the swept response will be displayed as two traces separated by this amount.

This facility is particularly suited to measurement of flatness.

(1) Set the sweep generator to display the response as described in Sect. 2.4, with the FINE LEVEL control at 0 dB and the FINE LEVEL SELECTOR at CONTINUOUS.

(2) Adjust the position of the display so that, say, the lowest portion of the trace is positioned on a convenient graticule line.

(3) Switch the FINE LEVEL SELECTOR to ALTERNATE and adjust the FINE LEVEL control so that the highest portion of the separated trace is positioned on the same graticule line.

(4) The indication of the FINE LEVEL control is then the total deviation from flat of the response.

Figs. 2.7 and 2.8 show the technique in use.

2.6 MARKERS

Markers are produced, either from internal crystal oscillators or from an external r.f. source. The MARKER FUNCTION switch selects which markers are provided and gives the following combinations.

markers at 100 MHz intervals
markers at 10 MHz intervals
markers at 1 MHz intervals
externally derived marker
markers at 100 MHz + 10 MHz intervals
markers at 10 MHz + 1 MHz intervals
markers at 100 MHz intervals + externally derived marker
markers at 10 MHz intervals + externally derived marker
markers at 1 MHz intervals + externally derived marker

For those positions of the MARKER FUNCTION switch where two different markers are provided, these occur on alternate traces. At the higher sweep speeds and with the FINE LEVEL selector at CONTINUOUS, both sets of markers appear superimposed on the same trace, but if the FINE LEVEL selector is set to ALTERNATE and the FINE LEVEL control adjusted, the trace carrying one set of markers will be separated from the trace carrying the other set - see Fig. 2.7.

Fig. 2.7 Full sweep, 100 MHz + 10 MHz pulse markers, alternate sweeps displaced by 1 dB

The markers are available at the MARKER OUTPUT socket for direct connection to the display device, but it is usually more convenient to add the markers to the detected sweep waveform before it is fed to the display device. To do this, connect the equipment as in Fig. 2.2 and set the controls to display the response of the unit under test.

An alternative way of displaying markers is to use them to intensity modulate an oscilloscope trace. A direct connection between the MARKER OUTPUT socket and the oscilloscope Z modulation input can be used, or if the oscilloscope has a low input impedance (such as TF 2210) the markers

would be better taken from the COMBINED OUTPUT socket. Turn the MARKER selector to PULSE and set the MARKER POLARITY switch to the position that gives brightening of the oscilloscope trace. The technique is demonstrated in Fig. 2.8. A combination of intensity modulation and normal marker display can be useful when oscillograms are to be photographed.

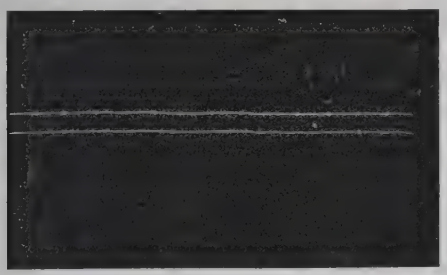


Fig. 2.8 130 MHz sweep width, 100 MHz + 10 MHz pulse markers intensity modulating the trace, alternate sweeps displaced by 0.2 dB

Marker form

A choice of birdie or pulse type markers for both internal and externally derived markers is available from the MARKER selector, and for pulse markers the MARKER POLARITY switch gives a choice of positive- or negative-going polarity. Use birdie markers when a clearly defined centre point is required and pulse markers when sharp edges and greater amplitude are wanted.

Fig. 2.9 6 MHz sweep width, 10 MHz + 1 MHz birdie markers, no trace separation

Adjust marker amplitude with the MARKER HEIGHT control (red knob) and set the MARKER DRIVE control (grey knob) to give the best shape to pulse markers. If the MARKER DRIVE control is set fully clockwise, additional markers at 50 MHz or 5 MHz intervals will be produced when 100 MHz or 10 MHz markers are in use.

Marker display on steep slopes

The testing of circuits where the output is a waveform having a steep slope can present problems of accurate frequency identification,

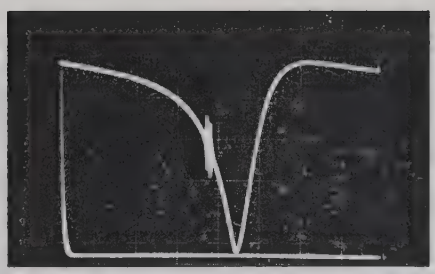


Fig. 2.10 Vertical marker on steep slope

because the angle between a marker and the slope is small, and the exact location of the marker ill-defined (Fig. 2.10). To overcome this, the markers can be added to the X-drive and adjusted so that they are at right-angles to the slope (Fig. 2.11). The markers shown in these illustrations are derived from an external c.w. signal and are displayed as birdie type, thereby defining the centre point of the marker. Internal markers can, of course, also be used: Fig. 2.2 shows a display of tilted 10 MHz pulse markers.

To produce tilted markers connect the equipment as in Fig. 2.13. With the two vertical inputs to an oscilloscope in the ADD 1 + 2 mode, adjustment of the marker angle can be produced by varying the gain of the oscilloscope channel carrying the markers.

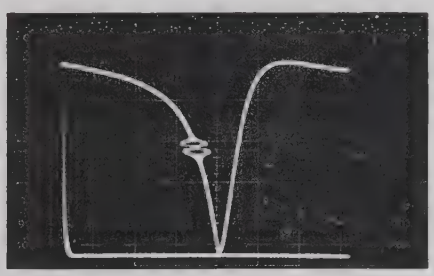


Fig. 2.11 Tilted marker on steep slope

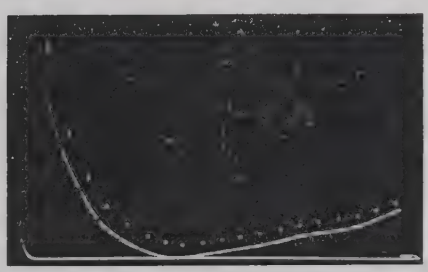


Fig. 2.12 Tilted pulse markers on steep slope

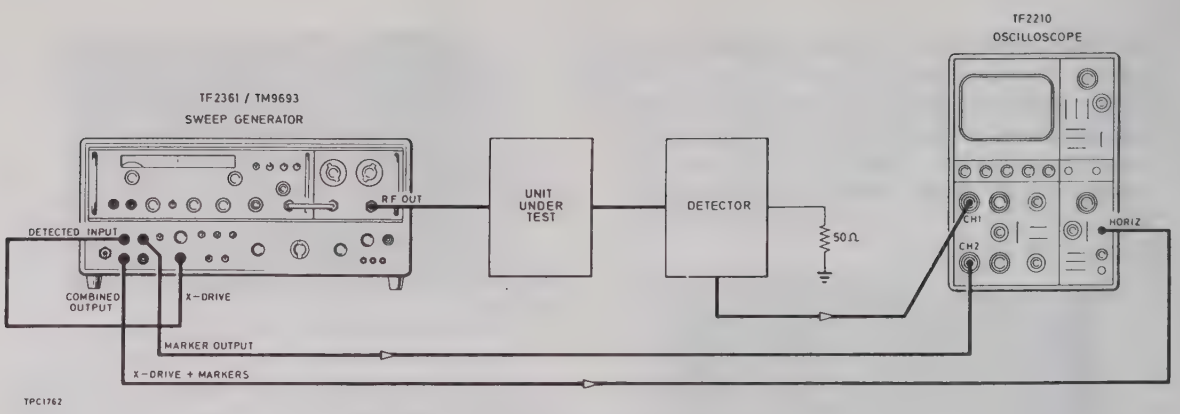


Fig. 2.13 Connections to produce tilted markers

Marker display on r.f. sweep

Whilst markers can be added to the detected sweep envelope from the unit under test, it is sometimes useful to see markers displayed directly on the r.f. sweep, provided that the oscilloscope used has a bandwidth that is capable of viewing the r.f.

To achieve this effect, the v.h.f. detector TM 9701 is used as a convenient means of adding the markers. Make connections as shown in Fig. 2.14. Set the MARKER POLARITY switch to + and adjust the MARKER HEIGHT control so that the markers can be seen on one side of the r.f. envelope. To display the markers on the other side of the r.f. envelope transfer the marker connection to the positive output of detector TM 9701 and set the MARKER POLARITY switch to -.

Under these conditions the flatness is not impaired and the markers are discernible but improved definition can be obtained by attenuating the r.f. output. The markers appear as part of the trace instead of being superimposed upon it.

2.7 EXTERNALLY LOCKED SWEEPS

To obtain a sweep locked to frequency of the a.c. supply connected to the instrument, turn the SWEEP FUNCTION switch to MAINS LOCK.

To obtain a sweep locked to the frame sync of a television signal, turn the SWEEP FUNCTION switch to TV and connect the reference signal to the EXTERNAL DRIVE INPUT socket. A sync separator circuit is fitted to the instrument and so locking is possible to a composite video signal, negative-going field pulses or to a sine wave; for the levels required see Data Summary, Sect. 1.2 of the main unit manual, EB 2361.

With either mains or TV lock the start of the sweep is locked to the supply or television waveform but the VARIABLE RATE control still functions and can be used (within its range) to alter the sweep speed. At high sweep speeds the sweep finishes and waits for the arrival of the next locking impulse. As the sweep speed is reduced the waiting time falls; when it has fallen below about 500 μs unstable locking may be experienced; when

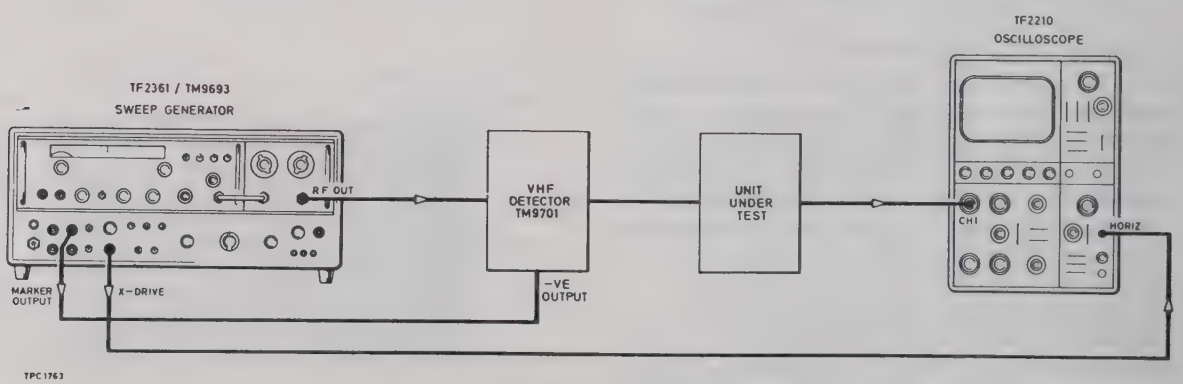


Fig. 2.14 Connections for marker display on r.f. sweep

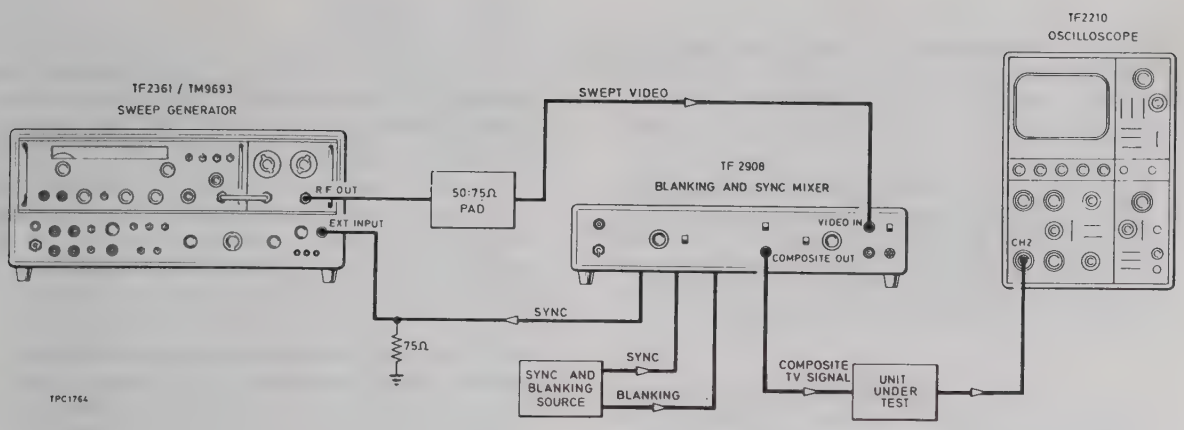


Fig. 2.15 Connections for swept video on composite television waveform

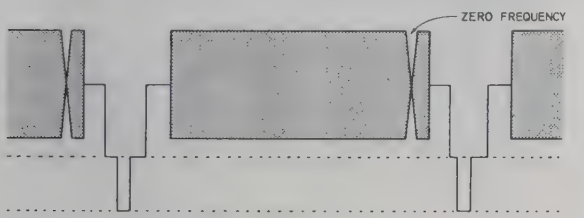
the waiting time has fallen below zero the sweep will lock in a stable fashion on alternate locking impulses.

All the other controls and facilities of the sweep generator apply as for the internal repetitive sweeps.

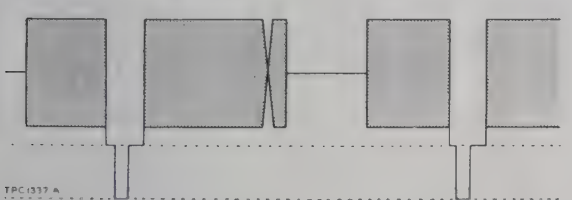
Phase shift

In either the mains or TV lock mode the phase relationship between the locking impulse and the start of the sweep can be altered by up to 270° using the PHASE SHIFT control. An example of the need to use phase shift occurs when it is desired to add swept video to a composite television signal.

To produce a composite television signal with swept video a source of sync and blanking signals is required and also a Sync and Blanking Mixer TF 2908. This technique is primarily intended for use with the Video Sweep Unit TM 9692 but can be used with TM 9693 if a suitable swept band is chosen and a 50:75 Ω adapter fitted to the R. F. OUTPUT. A suitable adapter is Greenpar 502-4840-708, 50 Ω type N male - 75 Ω BNC female. Make connections as shown in Fig. 2.15.



Video sweep centred in field period, ratio 10:1



Video sweep delayed about 200 degrees, ratio 10:1

Fig. 2.16 Effect of altering phase shift

The oscilloscope is used with its own time base for the horizontal deflection, internally triggered. Fig. 2.16 shows the resultant waveform, at frame period, with the RATIO switch at 10:1, if a 1:1 ratio is used the amount of the frame period occupied by the swept video is approximately halved. It is often required to see the effect of the video signal immediately following the field blanking; by adjustment of the PHASE SHIFT control, either the high frequency end or the low frequency end of the sweep can be positioned at this point.

2.8 EXTERNAL SWEEP

The sweep circuits can be driven by an externally produced signal which may be a ramp, sine wave or other waveform. The frequency response extends from d. c. to 20 kHz.

(1) Connect the external signal to the EXTERNAL DRIVE INPUT socket.

(2) With the SWEEP FUNCTION switch at 10 - 100 Hz measure, preferably using an oscilloscope, the peak-to-peak amplitude of the sweep drive at the SWEEP DRIVE MONITOR socket.

(3) Turn the SWEEP FUNCTION switch to EXTERNAL and adjust the EXTERNAL DRIVE SET LEVEL control so that the sweep drive amplitude is the same as previously measured.

(4) The sweep width controls can now be used as for internal sweeps and the calibration will give the total swept excursion. The centre frequency controls also function, but the calibration only applies if the input waveform is a ramp.

The sweep waveform and the X-drive waveform will follow that of the input provided that the SWEEP LINEARITY switch is at LINEAR. The normal facilities of external and internal a.l.c., external and internal markers, and fine level adjustment are available but blanking is not provided, nor is the alternate sweep facility.

2.9 MANUAL SWEEP

With the SWEEP FUNCTION switch at MANUAL the output frequency is determined by the VARIABLE RATE (MANUAL) control, within the limits set up by the SWEEP WIDTH and CENTRE FREQUENCY controls. A corresponding X-drive signal is available, as well as external and internal a.l.c., external and internal markers, and fine level adjustment; but blanking is not provided nor is the alternate sweep facility.

2.10 C.W.

With the SWEEP FUNCTION switch at C.W. the generator functions as a simple oscillator. The frequency is determined by the settings of the CENTRE FREQUENCY controls.

2.11 ONE SHOT

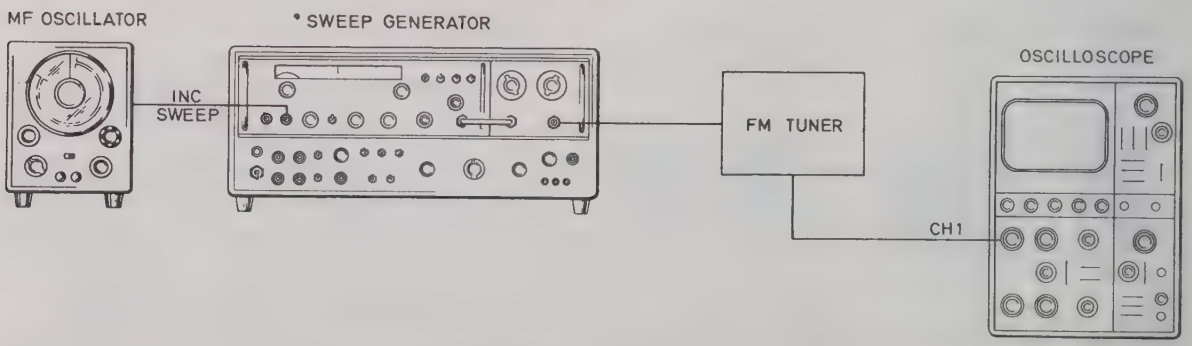
On all the internally generated sweep ranges, including TV and mains lock, it is possible to set the generator to operate in the 'one shot' mode, i.e. to perform one sweep and then stop. To achieve this, set the SWEEP MODE switch to ONE SHOT, press the ONE SHOT switch down and then release it; the switch is spring loaded and, as it returns to the upper position, the sweep will be initiated.

When the 'one shot' mode is selected the generator will complete the sweep being made, before the single shot can be initiated. This fact is of little consequence at the higher sweep rates but at the lower rates a waiting time of up to 100 seconds could be required. To avoid this, turn the SWEEP FUNCTION switch to the highest sweep rate and then back to the desired low rate after the 'one shot' mode has been selected.

Since it is not possible to tell which of the two alternate traces will occur next, when using the 'one shot' mode either avoid situations where the alternate traces would differ by setting the FINE LEVEL selector to CONTINUOUS and the MARKER FUNCTION switch to one of its first four positions, or if it is necessary to display separated alternate traces operate the ONE SHOT switch twice.

2.12 INCREMENTAL SWEEP

A separate input is provided so that an a.f. signal can be used to frequency modulate the generator when testing f.m. receivers. The effect is of superimposing frequency modulation upon the swept waveform already provided by the generator so that the receiver demodulator can be operated under its normal working conditions. A typical arrangement for receiver testing is illustrated in Fig. 2.17.



TPC 1522

Fig. 2.17 Connections for measuring response of f.m. tuners

The facility is available with all swept modes of operation as well as the c.w. mode. When used with the c.w. mode the instrument acts as an f.m. signal generator with a wide maximum deviation and low f.m. distortion, but without means of monitoring the deviation.

The applied signal passes through all the sweep drive circuitry and is affected by the setting of the SWEEP LINEARITY switch; with the switch at LINEAR, the deviation sensitivity is constant (within a 1.5:1 ratio) with r.f. output frequency, but with the switch at SEMI-LOG the sensitivity increases with frequency. With the switch at LINEAR, the deviation sensitivity may change abruptly (but still within 1.5:1 ratio) if the drive passes through one of the transition points of the distorter characteristic, and if this is unacceptable it may be better, with frequency excursions of up to a few MHz, to switch to SEMI-LOG when the change is gradual.

2.13 APPLICATIONS

Approximate v.s.w.r. measurements

To measure the approximate v.s.w.r. of the unit under test, connect the equipment as shown in Fig. 2.18, using at least a 2 m length of good 50 Ω cable between the detector and the unit under test. The v.s.w.r. is measured as $V_{max} : V_{min}$ on the oscilloscope display. If the level at zero frequency is greater than the mean level, then the impedance of the unit under test is greater than 50 Ω, and vice versa.

This test will also show variation of v.s.w.r. over the frequency range; if the amplitude of the displayed waveform decreases towards the right-hand side of the display, then the v.s.w.r. is better at the high frequency end of the range.

Location of faults in coaxial cables

For the location of faults in long, inaccessible lengths of coaxial cable, use the test connections shown in Fig. 2.18, disregarding the 'unit under test'. Only if the cable has no faults and is terminated at its remote end by its own characteristic impedance will there be no reflection of the sweep generator signal back into the detector; in all other cases there will be a reflected signal which will indicate the nature and position of the fault.

(a) Open-circuited cable

An open-circuit at the remote end of the cable being tested will cause a voltage maximum to exist at that end for all frequencies. The relative phase of the outgoing and reflected signals at the detector will, however, depend on the length of the cable and on the frequency.

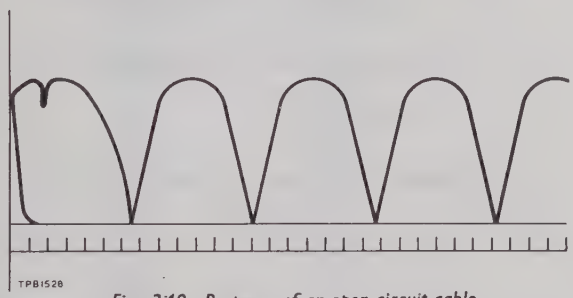


Fig. 2.19 Response of an open-circuit cable

At frequencies where the reflected signal total path length is an odd integral number of half wavelengths, the outgoing and reflected signals will be out of phase and minima will occur at the detector. At frequencies where the path length is an even number of half wavelengths, the outgoing and reflected signals will be in phase, and maxima will occur at the detector. The resultant display will therefore show a series of maxima and minima (Fig. 2.19).

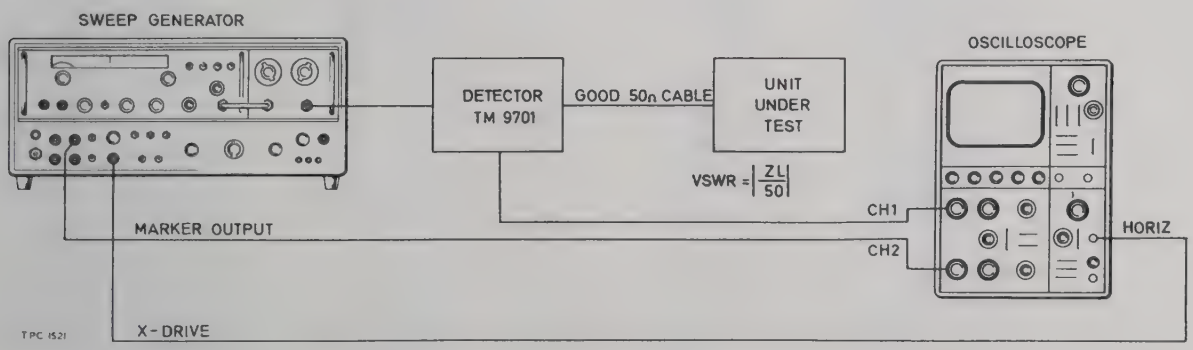


Fig. 2.18 Connections for approximate v.s.w.r. measurements

The longer the cable, the lower is the frequency at which the first minimum will occur, and the smaller is the frequency difference between minima. Unless cable losses are exceptionally high, they will not affect the frequency difference between minima, even though the minima will increase in voltage as the frequency rises. Using the following equations, the distance along the cable to the point of the open-circuit can be established.

$$2L = (2n - 1)\lambda_n \quad \text{and} \quad \lambda_n = \frac{V}{f_n}$$

where L = length of cable

f_n = frequency of the n^{th} minimum.

λ_n = wavelength in the cable of waves of frequency f_n

V = velocity of propagation of electromagnetic waves in the cable.

The cable length is half the total path length, so that

$$L = \frac{(2n - 1)\ V}{2\ f_n}$$

If the frequency difference between minima is Δf,

then $f = f_{(n+1)} - f_n$, and $L = \dfrac{V}{2\ \Delta f}$

For polythene cable, $V \simeq \dfrac{2c}{3}$ where $c = 3 \times 10^8$ m/s,

therefore $L = \dfrac{c}{3\ \Delta f}$

$= \dfrac{100}{\Delta f}$ metres, when f is measured in MHz.

(b) Short-circuited cable

If there is a short- circuit at the remote end of the cable, then there will be zero voltage at that end, and the frequency of the first minimum will be zero. However, the frequency difference between minima will be the same, and the equations given above are applicable.

(c) Partial short-circuit or open-circuit

A partial open-circuit or short-circuit will be indicated by high or low impedance, and this can be measured using the following equation.

$$Z = \left[\frac{Z^2_o\ V_2\ V_3}{(V_1 - V_2)\ (V_1 - V_3)}\right]^{\frac{1}{2}}$$

where Z_o = sweep generator output impedance

$V_{1,2,3}$ = voltages shown in Fig. 2.20.

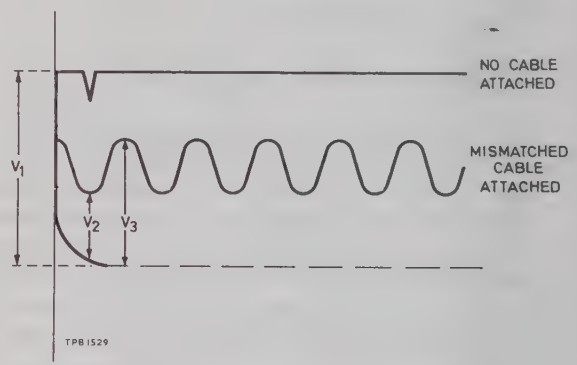
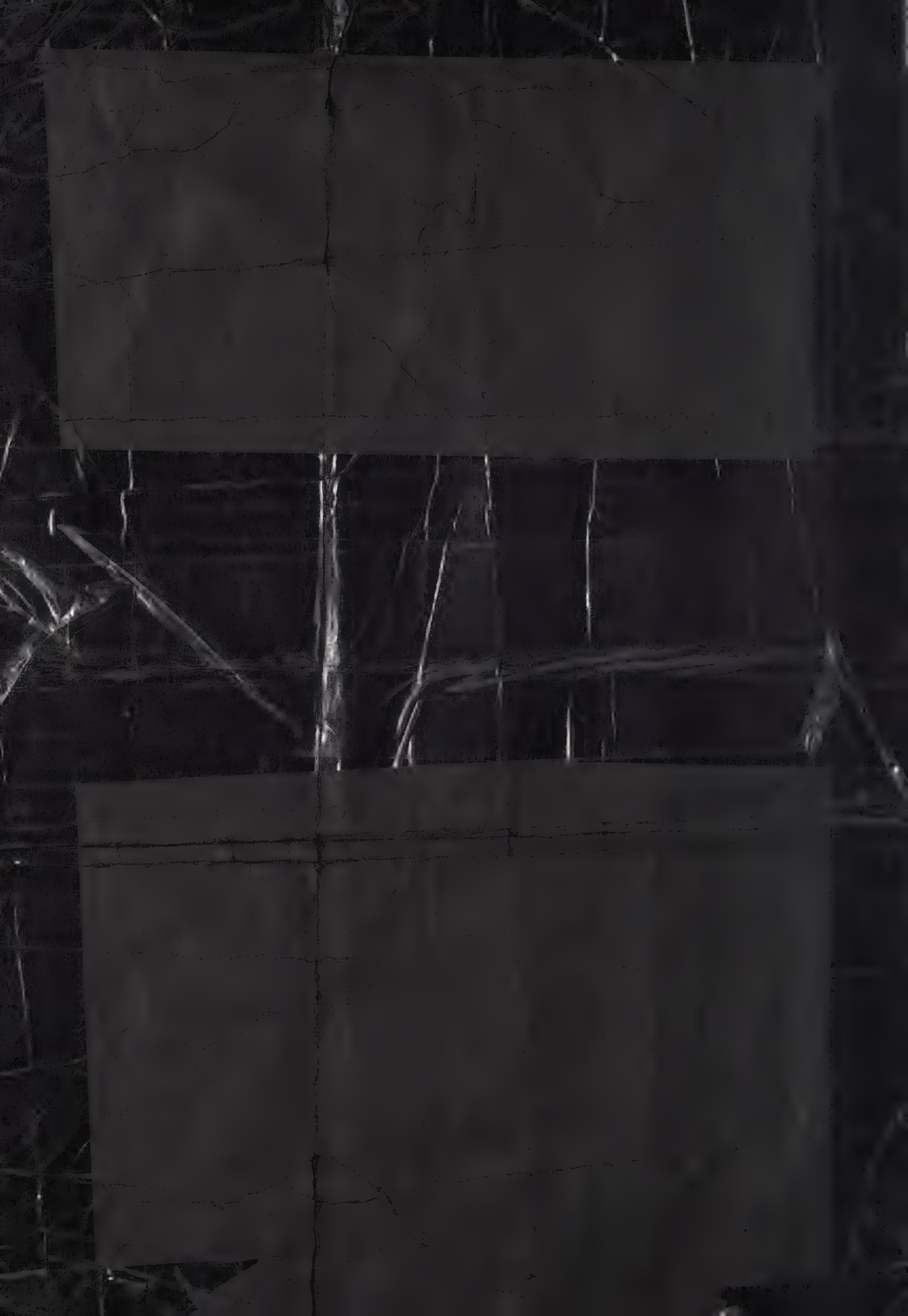
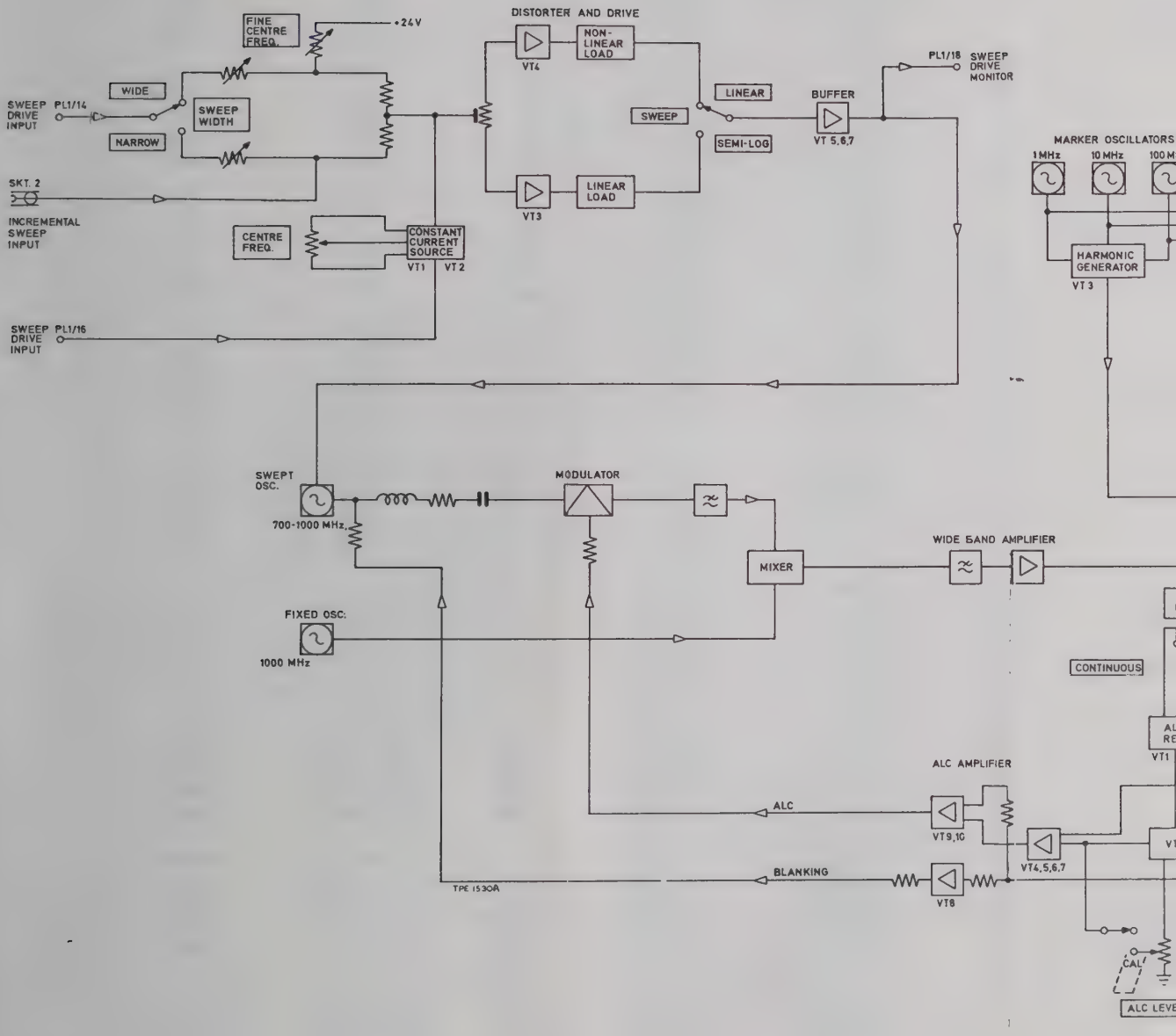


Fig. 2.20 Response of a mismatched cable

Decibel conversion table

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·7943	·6310	**2·0**	1·259	1·585
·7079	·5012	**3·0**	1·413	1·995
·6310	·3981	**4·0**	1·585	2·512
·5623	·3162	**5·0**	1·778	3·162
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	**22**	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	**28**	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	**32**	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	**34**	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	**36**	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	**38**	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	**40**	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	**42**	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	**44**	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	**46**	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	**48**	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	**50**	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	**60**	1,000	$1{\cdot}000 \times 10^{6}$




FINE CENTRE FREQ.
+24V
DISTORTER AND DRIVE
VT4
NON-LINEAR LOAD
PL1/18 SWEEP DRIVE MONITOR
WIDE
SWEEP DRIVE INPUT PL1/14
SWEEP WIDTH
NARROW
LINEAR
SWEEP
SEMI-LOG
BUFFER
VT 5,6,7
MARKER OSCILLATORS
1 MHz
10 MHz
SKT. 2
INCREMENTAL SWEEP INPUT
CENTRE FREQ.
CONSTANT CURRENT SOURCE
VT1
VT2
VT3
LINEAR LOAD
HARMONIC GENERATOR
VT 3
SWEEP DRIVE INPUT PL1/16
SWEPT OSC.
700-1000 MHz
MODULATOR
WIDE BAND AMPLIFIER
MIXER
FIXED OSC.
1000 MHz
CONTINUOUS
ALC AMPLIFIER
ALC
VT9,10
VT4,5,6,7
BLANKING
VT8
TPE 1530A
CAL
ALC LEVE

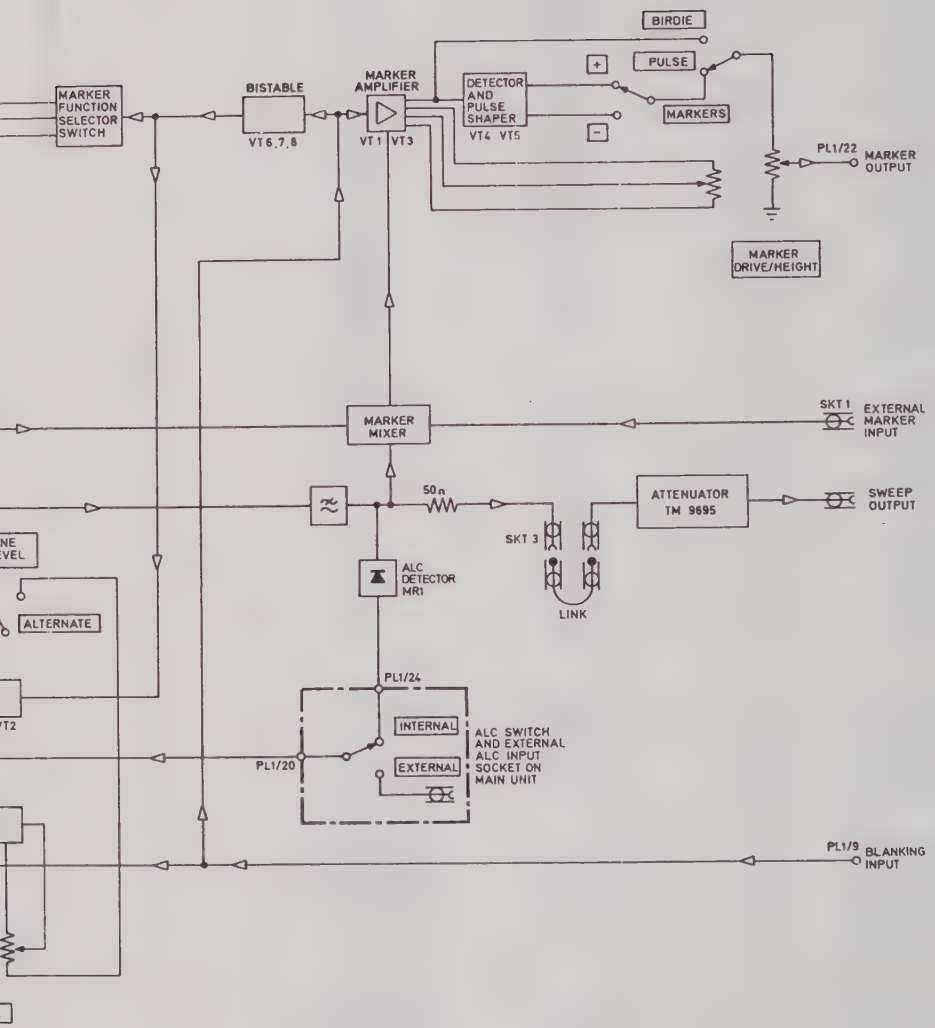


Fig. 3.1 VHF sweep unit TM 9693 block diagram

Chapter 3

Technical description

3.1 GENERAL

The following technical description should be read in conjunction with the block diagram Fig. 3.1 and the circuit diagrams included at the end of this manual.

The frequency-swept output signal is obtained by mixing the outputs from a swept oscillator operating between 700 and 1000 MHz, and a fixed oscillator operating at 1000 MHz. The difference frequency is used to provide an output of 0.5 V r.m.s. across 50 Ω swept from 0 to 300 MHz at maximum sweep width. A mechanical interlock between the sweep width and centre frequency controls restricts the sweep width at centre frequencies other than 150 MHz, and prevents the sweep extending more than approximately 15 MHz beyond zero or above approximately 315 MHz. Provision is made for either linear or semi-logarithmic sweeps, the latter being used to give expansion at the lower end of the frequency range.

All power supplies and the sweep drive are obtained from the main unit via the 24-pin plug-in connector. The sweep drive, in the form of a linear current ramp, is applied to the distorter and drive circuit, where control circuits are provided for control of sweep width and centre frequency. The distorter section of the circuit compensates for the non-linearity of the varactor used for varying the frequency of the swept oscillator. The output from the swept oscillator is taken through the a.l.c. modulator to a balanced mixer.

The difference frequency from the balanced mixer is applied to a low-pass filter and wideband amplifier, with an additional low-pass filter to remove unwanted frequencies above the maximum output frequency, caused by harmonics in the main amplifier. The sweep output is then connected to the attenuator TM 9695 via an external U-link.

The output to the attenuator is monitored by a negative peak a.l.c. detector, and the detected signal compared with a reference voltage to provide an error signal for the a.l.c. system. The error signal is fed through an a.l.c. amplifier and used to control the a.l.c. modulator. The reference voltage for the a.l.c. system can be adjusted to vary the output level by up to ±1 dB by means of a calibrated fine level control, and this variation can be applied to every sweep or to alternate sweeps only.

Flyback suppression can be switched in when required, and is effected by applying the blanking signal from the main unit to the sweep oscillator. The blanking signal inhibits the oscillator during the flyback period.

Three marker oscillators with a harmonic generator provide birdie markers or positive or negative pulse markers at 1 MHz, 10 MHz or 100 MHz intervals, or a single frequency marker can be displayed from an external source. The marker selection arrangements allow five different combinations of internal and external markers to be displayed on alternate traces, in addition to the selection of any one marker source.

3.2 DISTORTER AND DRIVE CIRCUIT

Circuit diagram—Fig. 7.2

The distorter and drive circuit (unit 33) provides a voltage swing in excess of 60 V to vary the frequency of the sweep oscillator. The shape of the output waveform depends on the position of the linearity switch, being concave in the linear position and linear in the semi-log position.

A current source VT2 provides a steady bias current which is divided between VT3 and VT4 via the preset equalizing control RV9. The sweep drive from the main unit in the form of a current ramp is fed into the collector circuit of VT2 via the sweep width selector and the sweep width controls RV1 or RV2. The centre frequency control circuit with RV7 and RV8 (RV8 is the zero setting preset control) varies the bias on the base of VT2, while fine centre frequency control is effected by RV4 varying the bias to the sweep width control circuit.

With the sweep width control set to maximum, all the sweep drive current is applied to the collector of VT2, so that maximum voltage swing is obtained at the output of VT2 and the swept oscillator frequency varies from 700 to 1000 MHz. With the sweep width control set to minimum the drive

current is reduced to zero, and the swept oscillator produces a fixed frequency determined by the setting of the frequency controls.

An additional input from the incremental sweep socket allows an a.f. input to give frequency modulation simultaneously with the normal sweep.

The distorter circuit compensates for the non-linearity of the varactor used to control the frequency of the swept oscillator, and this circuit forms the collector load for VT4, while the collector load for VT3 is linear. As a result, the linear current swing through VT3 and VT4 produces a linear voltage ramp at the collector of VT3 and a shaped voltage ramp of concave form at the collector of VT4, the final shape of the curve for the linear sweep being obtained from a combination of these two collector outputs. Several preset controls are provided in this circuit: RV14 for fine adjustment of distortion, RV6 and RV11 for setting the zero and 300 MHz limits of the semi-log sweep, and RV15 for setting the output level.

The distorter comprises a ladder circuit having 12 diodes, MR5 to MR16, shunt connected to progressively increasing voltage tappings on a resistor chain. As the current through the load increases, so does the voltage across it and consequently more diodes conduct, thus reducing the load impedance. In this way the ideal curve is closely matched by thirteen linear increments. The preset controls RV12 and RV13 provide slope adjustment at the critical low-voltage end of the ramp.

VT5, VT6 and VT7 comprise a high impedance buffer circuit which isolates the distorter from the output; the circuit has zero offset and unity gain, MR17 also ensures temperature compensation. A connection from the collector of VT7 is taken to the sweep drive monitor socket on the front panel of the main unit.

3.3 SWEPT OSCILLATOR

Circuit diagram—Fig. 7.2

The swept oscillator (unit 37) uses the varactor diode MR1 to tune the frequency from 700 to 1000 MHz. C1 and C3 are d.c. blocking capacitors which minimize the circuit inductance. The sweep voltage from the main unit, which may vary typically from 2 to 60 V, is applied via the r.f. blocking resistors R3 and R4.

The output is taken from the base of VT1 via a broadly tuned circuit to pass the swept frequency range. The inductance of L1 is critically chosen to establish a precise frequency-voltage characteristic, reduce spurious responses and reduce instability in the a.l.c. action.

Blanking is applied to the base of VT1, and when the blanking signal is switched on at the main unit the oscillator is inhibited during the blanking period to provide flyback suppression.

3.4 FIXED OSCILLATOR

Circuit diagram—Fig. 7.2

The fixed oscillator (unit 36) is similar to a Colpitts circuit, operating at approximately 1000 MHz. The exact frequency is set to match the more critical frequency of the swept oscillator.

The equivalent a.c. circuit of the oscillator, including the inductance of C1 and the transistor base-emitter capacitance, is as shown in Fig. 3.2. Although the voltage gain of VT1 may be less than unity, if the base-emitter capacitance is less than the capacitance of C2, then the feedback gain will be greater than unity and oscillation will be sustained, because the input impedance of the transistor is greater than the output impedance. C1 is a d.c. blocking capacitor; at 1000 MHz its capacitance has little effect, but an inductive element is introduced by raising the capacitor above the printed circuit board on ceramic spacers.

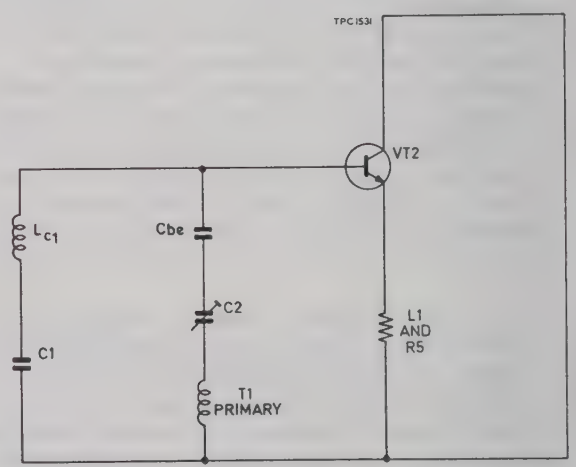


Fig. 3.2 Equivalent circuit of fixed oscillator

The primary of the output transformer T1 is formed by the small inductance of the trimmer capacitor C2, which sets the frequency while the secondary is a length of copper wire forming an external inductive pick-up which takes the output to the mixer.

3.5 A.L.C. MODULATOR

Circuit diagram—Fig. 7.2

The a.l.c. modulator (unit 38) comprises a diode-capacitor ladder which presents a varying degree of attenuation to the passage of the r.f. signal from the swept oscillator, the variation being effected by the d.c. signal from the a.l.c. amplifier.

Capacitors are used in the diode network to give a low-pass filter effect which reduces harmonics and spurious signals, improves the frequency response at the 300 MHz end of the range, and improves the forward loop gain.

The r.f. output from the modulator is taken through a low-pass filter formed by a length of stainless steel rod (L1) and the fabricated capacitors C3, C4. The capacitors are tuned to give maximum signal strength and harmonic rejection.

3.6 MIXER

Circuit diagram—Fig. 7.2

The mixer circuit (also on unit 38) comprises the diodes MR4, MR5 and the tuned circuit C6, C7, L3. The diodes conduct only on the negative half-cycles of the signal from the fixed oscillator, and during this period the impedance at the junction of the diodes is low. The signal from the swept oscillator then goes to earth through C6-C7, and not through L2. During the positive half-cycles of the fixed oscillator signal, the impedance at the junction of the diodes is high and the swept oscillator signal passes through L2 to the output. The output from the mixer therefore contains the sum and difference components of the swept and fixed oscillator frequencies, the difference component being the required signal which is passed by the filter circuit L2, R3, R4 and C8.

The tuned circuit C6, C7 and L3 is set to resonate at the fixed oscillator frequency, C6-C7 being adjusted by a single nut and L3 (fine tuning) by a slug.

3.7 WIDEBAND AMPLIFIER

Circuit diagram—Fig. 7.2

The wideband amplifier (unit 34) is a four-stage R-C coupled amplifier with an emitter-coupled push-pull output stage. The 0 to 300 MHz input from the mixer passes through a three-stage constant-k low pass filter to the first amplifier stage VT1. The first three amplifier stages are similar, except that the third stage has an inductor to give additional gain at frequencies below 5 MHz.

The push-pull output stage comprises a long-tailed pair VT4 and VT5, where the signal is applied to VT4 base and the base of VT5 is at earth potential. Equal and opposite currents then flow in the two transistors and the auto-transformer provides the required phase inversion to sum the signal for the output.

3.8 LOW PASS FILTER, A.L.C. DETECTOR AND MARKER MIXER

Circuit diagram—Fig. 7.4

The low pass filter, a.l.c. detector and marker mixer (unit 35) are all associated with the sweep output. The low pass filter removes harmonics and spurious signals above 300 MHz. The output of this filter also goes to the a.l.c. detector (MR1 and associated components) and to the marker mixer (MR2, MR3, MR4 and associated components).

The a.l.c. detector circuit includes a compensation network for the falling frequency response characteristic of the attenuator; by having a similar characteristic (0.9 dB down at 300 MHz) the a.l.c. circuit gives the necessary rise in sweep output level to give a flat response at the output of the attenuator TM 9695. The preset control RV1 provides slope adjustment. The d.c. output from the detector is integrated by the 100 pF capacitor C5, and the series resistor R3 prevents r.f. being reflected back into the detector circuit. The point to which the a.l.c. detector is connected is maintained at a level independent of load, and hence is zero impedance. To achieve a 50 Ω output impedance, therefore, a 50 Ω resistor is included in series with the output.

The marker mixer circuit receives a fraction of the r.f. sweep signal via R1 (low frequencies) and C8-C15 (high frequencies). The mixer diode is MR2, which conducts on the negative half-cycles of the switching signal derived either from the internal harmonic generator or from the external marker input signal. MR3 and MR4 are switching diodes which allow the external marker signal to be applied to the mixer only when the front panel marker function switch is in one of the 'external' positions. The output from the mixer is fed to the marker amplifier via the low pass filter R6, C10 and C11 and comprises the difference btween marker frequency and signal frequency, restricted to a maximum of about 250 kHz.

3.9 A.L.C. AMPLIFIER

Circuit diagram—Fig. 7.4

The a.l.c. amplifier (unit 32) comprises the amplifier, the a.l.c. reference circuit, and the coarse and fine a.l.c. circuits.

In the reference circuit, a reference voltage is derived from the emitter of VT3, proportional to the current through VT3. This current is the difference between the current through R9 and the current through RV3; the fine level control varies the current through R9, while RV3 is used to preset the ±1 dB range of control. Another preset control RV2, used in conjunction with RV3, establishes the reference level without altering the ±1 dB range. The a.l.c. level control is effectively across R8.

The output from the a.l.c. detector forms the input to the high impedance FET source follower VT7, where the offset voltage is set to zero by RV5. The signal is then compared with the reference voltage by the high gain differential amplifier VT4 and VT5, high gain being established by the high dynamic impedance of the p.n.p. transistor VT6 in the collector circuit of VT5.

The output stage emitter followers VT9 and VT10 have high input impedance and low output impedance, with a feedback path through C1 which is an integrating capacitor giving a time constant sufficiently long to prevent instability or low-frequency distortion.

The alternate trace facility operates through VT1 and VT2, which conduct alternately on every other trace because of the +24 V switching input on their emitters derived from the bistable on the marker amplifier board (see Fig. 3.3). With the fine level switch in the alternate position, when VT1 conducts the reference level is determined by the preset control RV1; when VT2 conducts the reference level is determined by the fine level control. With the switch in the continuous position, only MR2 conducts and the fine level control is operative on every trace.

When the blanking signal is switched on and flyback suppression in operation, there will be no output from the a.l.c. detector, with a consequent large error signal that could drive the amplifier out of control. To prevent this, the blanking

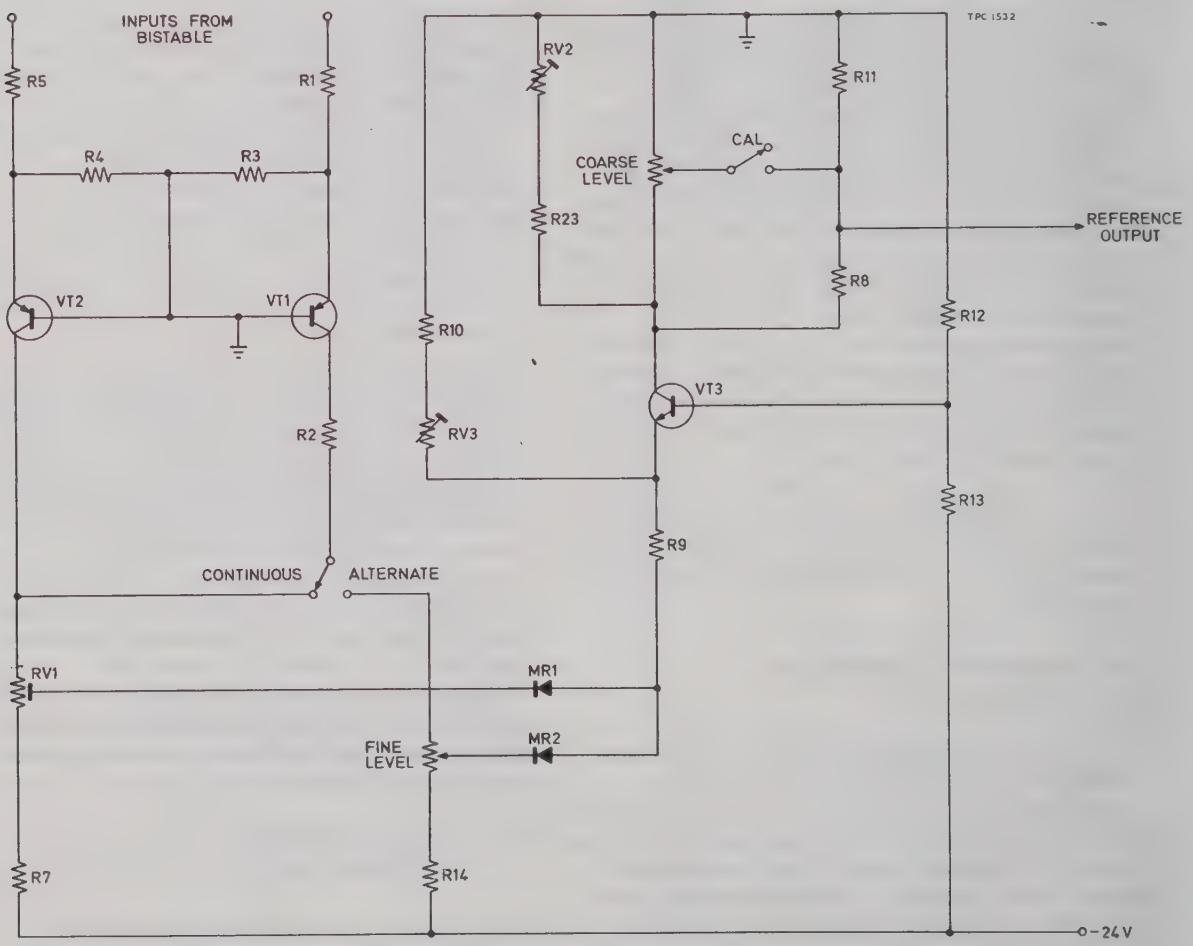


Fig. 3.3 Operation of alternate trace circuit

signal is applied to the amplifier, and MR5 and RV6 simulate a level from the a.l.c. detector whenever the blanking voltage is zero. The blanking signal which switches MR5 is inverted by VT8 and used to apply flyback suppression to the swept oscillator.

3.10 MARKER OSCILLATORS

Circuit diagram—Fig. 7.4

The marker oscillator circuit (unit 30) comprises three crystal oscillators operating at 1 MHz, 10 MHz and 100 MHz, and a harmonic generator which gives harmonics of these frequencies up to at least 300 MHz.

The front panel marker function switch selects the required oscillators and switches them on, and provides for different markers on alternate traces. Direct switching is used for the 100 MHz oscillator, while for the others transistor switching is used to ensure instantaneous operation.

Each oscillator uses a Colpitts circuit with a series resonant crystal in the feedback path, and a separate resonant tank circuit to prevent oscillation at frequencies other than the fundamental.

The 100 MHz oscillator has a variable capacitor in the tuned circuit, precise tuning being necessary to pick up the fifth overtone of the crystal; L6 and C7 remove any tendency to oscillate at a lower overtone. Switching is effected by applying +24 V to the supply rail.

The 10 MHz oscillator is switched on by VT5, when this transistor is held in the non-conducting state by +24 V applied to pin 3. The oscillator output then passes to VT4 base and switches this transistor on and off. VT2 is thus switched on and this provides a fast reversal of current through the step recovery diode VT3, so that the current builds up to a large value in the reverse direction before the stored change is dissipated and the rapid recovery action reduces it to zero again.

The harmonic generator uses the base-collector junction of VT3 as a step recovery diode to produce output pulses having a very rapid rise-time at the repetition frequency of the input signal, thus producing a comb distribution. A forward current of about 10 mA is fed to the diode via MR2 (10 MHz) or MR3 (1 MHz) and R7 when either of these oscillators are switched on. The filter C11, C12 and L3 (which is a short length of track on the printed circuit board) removes all but the initial spikes produced by the step recovery diode, and levels the distribution of energy between the low and high frequencies. The output from the 100 MHz oscillator is fed direct to the output of the harmonic generator as an adequate harmonic content is already present.

3.11 MARKER AMPLIFIER

Circuit diagram—Fig. 7.4

The marker amplifier (unit 31) receives the difference input from the marker mixer (see para. 3.8). This input is the difference between the sweep frequency and the internal and/or external marker frequencies.

VT1 and VT2 form the first stage of the amplifier, providing high input impedance with bandwidth limiting to give a clear gap between 1 MHz markers. The stage output is fed through the marker drive control to the amplifying stage VT3. A blanking input is applied to VT3 so that this stage is switched off during the blanking period to remove possible spurious signals.

The output of VT3 is the birdie marker output which is fed to the marker selector switch. To obtain positive and negative pulse markers, the birdie markers are rectified by the full-wave rectifier circuit T1, MR1 and MR2 followed by the switching transistors VT4 (negative pulse output) and VT5 (positive pulse output). Diodes in each pulse output circuit clip the pulses and protect the transistors from externally-applied transients.

Included on this board is the bistable circuit which provides the supplies to operate the alternate trace facility and to enable the markers to be switched to alternate traces. The blanking input is differentiated by R20 and C13, and the positive edges are removed by MR8. The negative going edges switch on VT6, and VT7 and VT8 are triggered alternately at the end of each sweep. MR11 and MR12 protect the base-emitter junctions of VT7 and VT8 from positive transients, and MR9 and MR10 prevent the collectors from going negative. The two outputs are taken from the collectors, which effectively go to +24 V on alternate traces.

3.12 POWER SUPPLIES

All power supplies are received from the main unit via the 24-pin connector, pin 1 (+24 V), pin 5 (-24 V) and pin 3 (+110 V). The +110 V supply is only used in the distorter and drive unit, while the ±24 V supplies are used on all the main boards.

3.13 ATTENUATOR TM 9695

Circuit diagram—Fig. 7.5

The attenuator unit TM 9695 contains two stepped attenuators: a coarse attenuator unit, giving up to 50 dB loss in 10 dB steps and a fine attenuator giving up to 11 dB loss in 1 dB steps.

Both attenuators are of similar construction and operation. The pad sections consist of resistive π networks with a characteristic impedance of 50 Ω.

Electrical shielding is provided in each attenuator unit by a metal casting divided into compartments which house the pads. The dimensions of the casting, together with the pads, bypass links and microswitches have been designed to maintain the characteristic impedance. Provisions are made by controlling the spacing of the components and adjustment of stray reactance, to ensure the maintenance of performance up to 1000 MHz.

Pads are brought into circuit by microswitches housed inside the screened compartments and operated, in pairs, by leaf springs which are themselves actuated by cams on the control spindles.

Chapter 4

Maintenance

4.1 INTRODUCTION

This chapter contains information for keeping the equipment in good working order and for checking its performance. If the instrument fails to pass any of the tests, refer to Chap. 5, Repair.

4.2 PERFORMANCE CHECKS

4.2.1 Test equipment required

This section provides list of the test equipment that will be required to carry out the performance checks detailed in this chapter.

Item

a Oscilloscope, M.I. TF 2201 or M.I.TF2210.

b Signal generator, 1 to 300 MHz, such as M.I. TF 801D and M.I. TF 144.

c V.H.F./U.H.F. Detector, M.I. TM 9701 *

d 50 Ω termination, GE 87010 *

* Accessories supplied with instrument.

4.2.2. Initial Conditions

Performance faults in the main unit are likely to invalidate any performance checks on the plug-in sweep unit, and it is therefore essential that the main unit should be checked first. For the following checks, the sweep unit and attenuator should be fitted in the main unit, with the complete instrument in its case.

Set the front panel controls to the following positions:

(A) Main unit

SUPPLY switch ON.
SWEEP FUNCTION switch at 10 - 100 Hz.
VARIABLE RATE control at mid-position.
RATIO switch at 1:1.
SWEEP MODE switch at NORMAL.
BLANKING switch ON.
A.L.C. switch at INTERNAL.
MARKER switch ON.
X-DRIVE LEVEL control fully counter-clockwise.
X-DRIVE switch at FORWARD.

(B) Sweep unit

SWEEP WIDTH control fully clockwise.
SWEEP WIDTH SELECTOR at WIDE.
CENTRE FREQUENCY control to give 150 MHz on scale.
FINE CENTRE FREQUENCY control at mid-position.
MARKER DRIVE and HEIGHT controls at mid-position.
MARKER SELECTOR and POLARITY switch at PULSE and +.
MARKER FUNCTION switch at 100 MHz.
SWEEP LINEARITY switch at LINEAR.
FINE LEVEL switch at CONTINUOUS.
A.L.C. LEVEL control fully clockwise (CAL).
FINE LEVEL CONTROL at mid-position (0 dB).
Both attenuation controls at 0 dB.

4.2.3 Frequency range and sweep width

Test equipment: (a), (c) and (d)

(1) Connect the oscilloscope horizontal input to the X-DRIVE OUTPUT socket, and the vertical input to the COMBINED OUTPUT socket. Connect the v.h.f. detector to the ATTENUATOR OUTPUT socket and terminate it with the 50 Ω termination. Connect the detector negative output to the oscilloscope vertical input, inverted if possible.

(2) Set the oscilloscope sensitivity to 0.2 V/cm and adjust the X-DRIVE LEVEL control so that the displayed waveform fills the graticule.

(3) Adjust the MARKER DRIVE and MARKER HEIGHT controls so that clear 100 MHz markers are displayed, and check that the zero break and 300 MHz markers are visible on the display, as shown in Fig. 4.1.

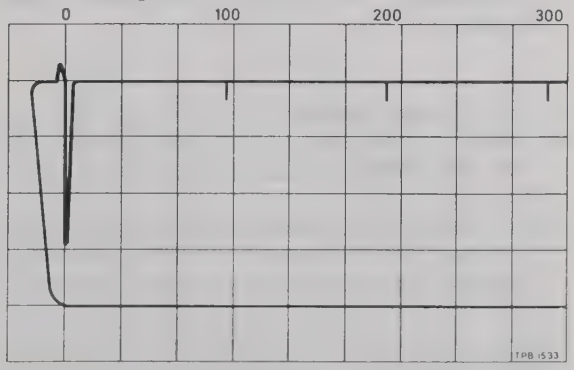


Fig. 4.1 Display for frequency range check

(4) Adjust the SWEEP WIDTH control counter-clockwise to zero, and check that the displayed sweep width reduces progressively to zero centred on 150 MHz. Switch in 10 MHz markers as the sweep width is progressively reduced to zero (control counter-clockwise), and check that at zero it is centred on 150 MHz.

(5) Adjust the SWEEP WIDTH control fully clockwise, and check that markers are evenly positioned over the total width of the display.

(6) Adjust the SWEEP WIDTH and CENTRE FREQUENCY controls to set the zero break and 300 MHz markers on the left-hand and right-hand edges of the graticule respectively. Check that the reading on the sweep width dial is 300 MHz ±25 MHz.

(7) Reduce the sweep width until the 50 MHz and 250 MHz markers are displayed on the edges of the graticule. Note that if the 100 MHz markers are switched on, 50 MHz markers will appear in addition to the 100 MHz markers if the marker drive control is turned clockwise; in the same way, 5 MHz markers will appear in addition to the 10 MHz markers. Check that the reading on the sweep width dial is 200 MHz ±20 MHz.

(8) Reduce the sweep width until the 100 MHz and 200 MHz markers are displayed on the edges of the graticule, and check that the SWEEP WIDTH dial reading is 100 MHz ±15 MHz.

(9) Reduce the sweep width until the 140 MHz and 160 MHz markers are displayed on the edges of the graticule, and check that the SWEEP WIDTH dial reading is 20 MHz ±11 MHz.

(10) Set the SWEEP WIDTH control to maximum (fully clockwise) and the SWEEP WIDTH selector to NARROW. Check that the CENTRE FREQUENCY control can be adjusted so that any two adjacent 10 MHz markers are displayed near the edges of the graticule. Return the SWEEP WIDTH selector to WIDE.

4.2.4 Sweep linearity

Test equipment: (a), (c) and (d)

(1) Set the SWEEP FUNCTION switch to MAINS LOCK and the RATIO switch to 10:1. Set the MARKER HEIGHT control fully clockwise.

(2) Adjust the PHASE SHIFT control until the left-hand edge of the marker display (10 MHz markers) is at the left-hand edge of the graticule, and then adjust the VARIABLE RATE control until the displayed waveform fills the graticule.

(3) Set the oscilloscope expansion to x5 and measure the intervals between each adjacent pair of 10 MHz markers from 0 to 300 MHz, using either the graticule or the time scale according to the type of oscilloscope in use. Use the oscilloscope horizontal shift control to bring each end of the display into view. Check that the ratio of the largest interval to the smallest interval does not exceed 1.5:1.

4.2.5 Centre frequency calibration and output amplitude

Test equipment: (a), (b), (c) and (d)

(1) Revert to the initial conditions detailed in Sect. 4.2.2.

(2) Switch to 10 MHz markers and adjust the SWEEP WIDTH selector until 3 markers are displayed. Use the CENTRE FREQUENCY control, adjust to every 10 MHz setting in turn, and check that the corresponding marker is within 5 MHz of the centre of the display, i.e. half the interval between 10 MHz markers.

(3) Connect the signal generator output to the EXTERNAL MARKER INPUT socket on the sweep unit, and set it to 300 mV p-p at about 5 MHz. Set the MARKER FUNCTION to EXTERNAL and the LINEARITY switch to SEMI-LOG. Set CENTRE FREQUENCY control to 0. Adjust the signal generator frequency until the external marker is visible in the centre of the display. The signal generator frequency must then be less than 5 MHz.

(4) Set the signal generator at 300 MHz, 300 mV p-p output amplitude. Set the MARKER FUNCTION switch to EXTERNAL, and the CENTRE FREQUENCY control to 300 MHz. Adjust the signal generator frequency until the external marker appears at the centre of the display. The signal generator must then read 300 MHz ±30 MHz.

(5) Set the SWEEP LINEARITY to LINEAR and the MARKER FUNCTION switch to 1 MHz markers. Adjust the CENTRE FREQUENCY and SWEEP WIDTH controls until ten 1 MHz markers fill the graticule.

(6) Adjust the FINE CENTRE FREQUENCY control from zero to fully counter-clockwise and back through zero to fully clockwise. Check that

the markers move through 3 cm to the right and left during the adjustment.

(7) Disconnect the v.h.f. detector and connect the oscilloscope vertical input to the ATTENUATOR OUTPUT socket, using a 50 Ω cable and the 50 Ω termination connected via a T connector at the oscilloscope end of the cable.

(8) Switch the MARKER selector to EXTERNAL and set the oscilloscope sensitivity to 0.5 V/cm. Check that the p-p amplitude of the display near the zero break is 1.414 V (2.828 cm) ±5%. When making this check, the accuracy of the oscilloscope being used must be taken into account.

(9) Remove the 50 Ω termination of the oscilloscope, set the attenuator to 6 dB, and check that the amplitude of the displayed waveform is the same as before ±5%.

(10) Reconnect the 50 Ω termination on the oscilloscope. Check that the fine and coarse attenuators function correctly, by noting the progressive reductions in level as the attenuation is increased. Adjust the oscilloscope sensitivity to maintain a readable display during this check.

4.2.6 Detected system flatness

Test equipment: (a), (c) and (d)

(1) Reset the instrument to the initial conditions detailed in Sect. 4.2.2, except for the following:

FINE LEVEL control at +0.5 dB.
FINE LEVEL selector switch at ALTERNATE.
MARKER switch OFF.

(2) Connect and set up the oscilloscope as detailed in Sect. 4.2.3 (1).

(3) Increase the oscilloscope sensitivity as far as the vertical shift control allows without losing the top of the display, and check that the two traces can be positioned so that they are above and below the horizontal centre line of the graticule without overlap, as shown in Fig. 4.2.

(4) Set the SWEEP WIDTH switch to NARROW and adjust the NARROW control to zero (fully counter-clockwise). Increase the oscilloscope sensitivity as far as the vertical shift control allows without losing the top of the trace. Set the FINE LEVEL control to -1 dB, and check that two traces appear.

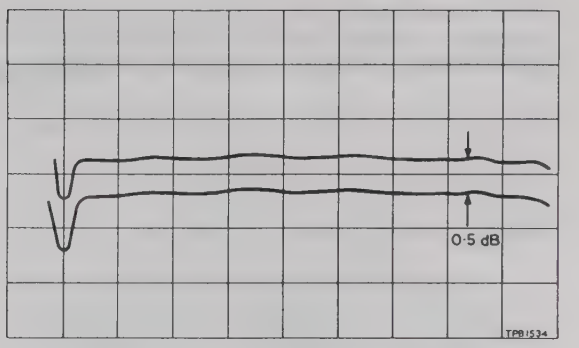


Fig. 4.2 Display for detected system flatness

(5) Set the fine attenuator switch to 1dB, and align the top trace with a graticule line. Then switch the fine attenuator back to 0 dB and adjust the FINE LEVEL control until the bottom trace is aligned with the same graticule line. While doing this, it will be necessary to switch rapidly from 0 dB to 1dB several times to obviate oscilloscope drift. Check that the FINE LEVEL control indicates -1 dB ±0.1 dB.

(12) Repeat for the +1 dB condition, by adjusting the FINE LEVEL control to +1 dB and aligning the bottom trace to a graticule line. Switch the fine attenuator between 0 and 1 dB while adjusting the FINE LEVEL control to position the top trace on the same graticule line as the previous bottom trace. Check that the FINE LEVEL control indicates +1 dB ±0.1 dB.

(13) Revert to the initial conditions, and move the A.L.C. LEVEL control (red) away from the switched CAL position. Check that the amplitude of the trace increases, and that further counter-clockwise rotation of the control reduces the amplitude to well below its original level. Return the control to the switched CAL position.

4.2.7 Incremental sweep

Test equipment: (a), (c) and (d)

(1) Set the SWEEP WIDTH selector to NARROW, the MARKER FUNCTION switch to 1 + 10 MHz, and the oscilloscope sensitivity to 5 V/cm.

(2) Display an approximate 10 MHz sweep, with a 10 MHz marker in the centre; this can be identified as the marker that does not 'flicker'.

(3) Connect a 4.5 V battery to the incremental sweep input socket, positive to centre and negative

to shield, and check that the 10 MHz marker moves approximately 1 MHz to the right on the display.

4.2.8 Internal and external markers

Test equipment: (a), (b), (c) and (d)

(1) Reset the instrument to the initial conditions detailed in Sect. 4.2.2 and connect the vertical input of the oscilloscope to the marker output socket on the main unit.

(2) Set the oscilloscope sensitivity to 5 V/cm and display the 10 MHz markers. Adjust the MARKER DRIVE control as required and set the MARKER HEIGHT control fully clockwise. Check that the amplitude of both positive and negative pulse markers is at least 15 V. Readjust the MARKER DRIVE control, if necessary, when switching from positive to negative markers.

(3) Connect the signal generator output to the EXTERNAL MARKER input socket and set it for 300 mV p-p output. Set MARKERS selector to BIRDIE. Set the MARKER FUNCTION switch to 10 MHz + EXT, and tune the signal generator frequency between 1 and 300 MHz. Check that the external marker appears at all frequencies over the range. Switch off supplies and disconnect all test equipment.

Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for adjustment or repair following failure of the instrument to pass any of the performance checks detailed in Chapter 4.

Before attempting any adjustment or repair, read the technical description given in Chapter 3.

CAUTION

This instrument uses semiconductor devices which, although having inherent long-term reliability and mechanical ruggedness, are susceptible to damage through overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as reversed potentials, prolonged soldering, strong r.f. fields or other forms of radiation, use of insulation testers or accidentally applied short circuits. Even the leakage current from an unearthed soldering iron could cause trouble. Before shorting or breaking any circuit, refer to the circuits diagrams to establish the effect on bias arrangements of any associated transistors.

The performance limits quoted in this chapter are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the Data Summary section.

5.2 SCREW FASTENERS

Screw threads used on this equipment are of the following sizes: 8 BA, 6 BA, 4 BA and 2 BA.

Cruciform headed screws are of the Pozidriv type; to avoid damaging them a Pozidriv screwdriver should be used.

5.3 REMOVAL OF UNIT

The sweep unit can be removed from the attenuator TM 9695 framework by releasing the two knurled thumbscrews on the front panel, removing the link to the attenuator and withdrawing the unit forward out of its recess. Use slow, even pressure when engaging and disengaging the 24-way connector at the rear of the unit.

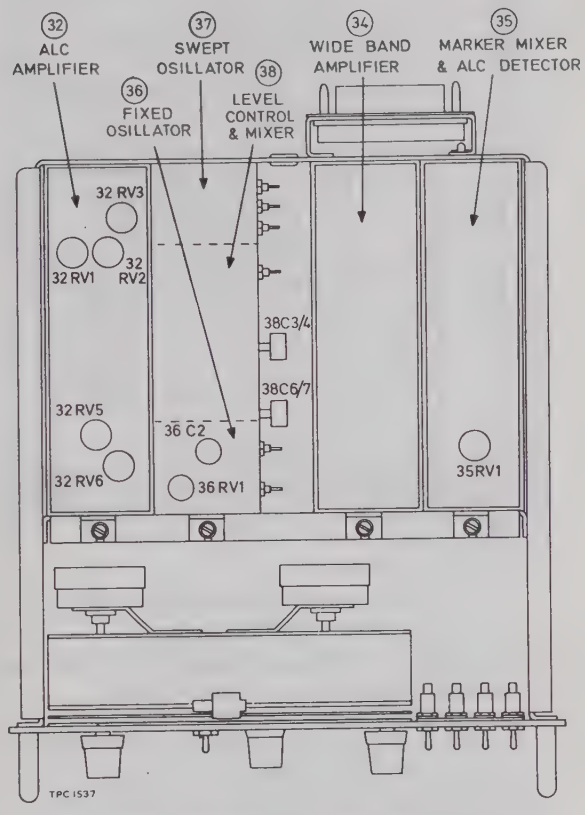


Fig. 5.1 Location of units and preset controls top of chassis

The attenuator or attenuator/sweep unit assembly can be removed from the main unit TF 2361 by releasing the two knurled thumbscrews on the front panel and withdrawing the unit forward out of its recess.

5.4 ACCESS TO PRINTED CIRCUIT BOARDS

The nine printed circuit and circuit boards are accessible from the top and underside of the sweep unit chassis, and are arranged as shown in Figs. 5.1 and 5.2. Most printed circuit boards are mounted in boxes, and can be raised out of them for inspection or repair by removing the four 6 BA screws holding them in position; if necessary they can be completely removed by disconnecting the wired terminals which are pressed on to spigots on the board and unsoldering any soldered connections. It is possible to get a test probe on to these terminals without removing the wires, a short section of

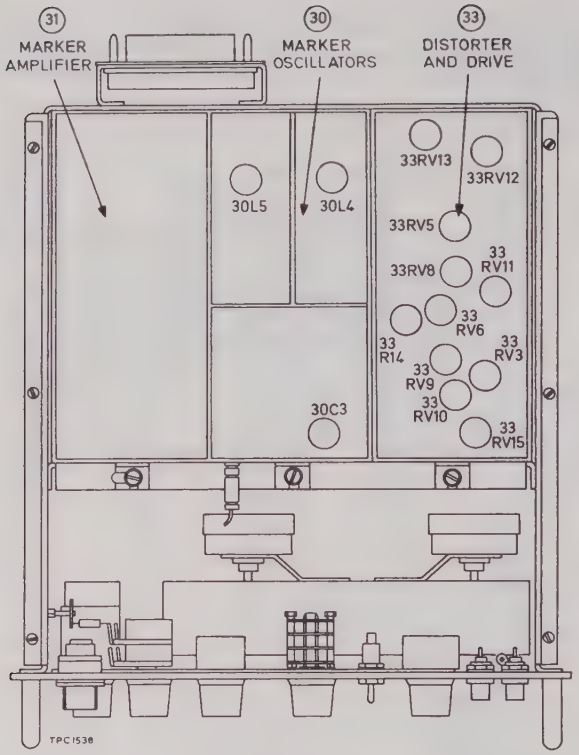


Fig. 5.2 Location of units and preset controls, underside of chassis

the spigot being left exposed between the board and the insulated sleeving round the terminal.

All the boxes containing boards are fitted with covers; the cover on the box containing the two oscillators and mixer is secured with four 6 BA screws, while all the other covers are of the clip-on type. To remove a clip-on cover, lever it off by inserting the blade of a small screwdriver under the lip provided for this purpose.

If it is found necessary to remove a printed circuit board for return to the manufacturer, it should be removed complete with its box. Each box is held in position by four 4 BA screws, two on a flange at the front and two at the rear.

CAUTION

When removing, inserting or working on printed circuit boards, take care not to bend them or to damage the printed circuit tracks on the underside of the boards. Bending can cause hairline breaks in a track, and such breaks are very difficult to locate.

All preset controls are mounted on the printed circuit boards accessible from the top or underside of the chassis. For the location of these controls, refer to Figs. 5.1 and 5.2.

The attenuators are precision devices requiring during their manufacturer specialized jigs and test apparatus. They rely for the maintenance of their high frequency performance on close electrical and mechanical limits. You are recommended, therefore, not to attempt any repair and, if the attenuators need attention, to return them to our Service Division.

5.5 COMPONENT LOCATION

Component location diagrams are shown in Figs. 5.3 to 5.13, and these diagrams also show the location of the board terminals. For front panel components, refer to Fig. 2.1.

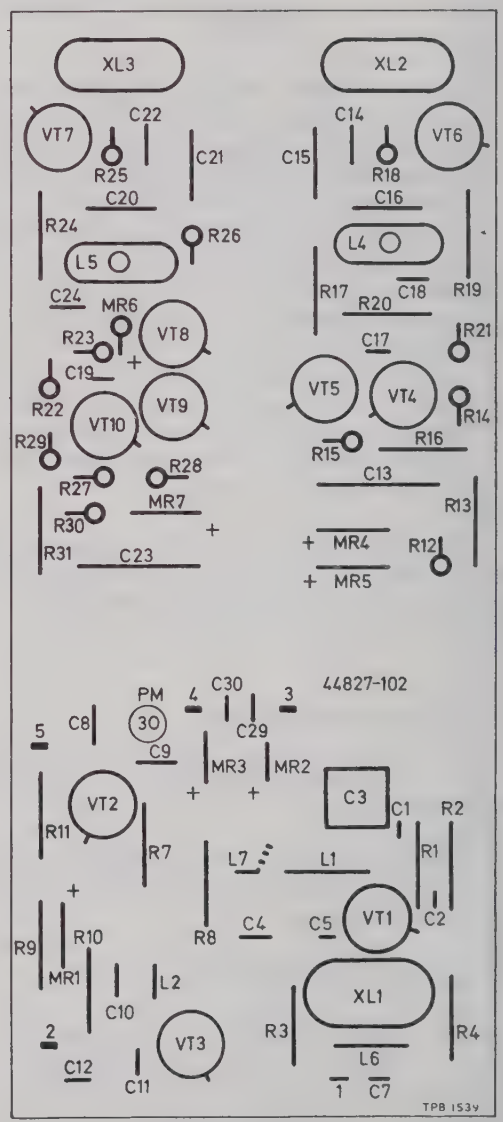


Fig. 5.3 Component location, board 30, marker oscillators

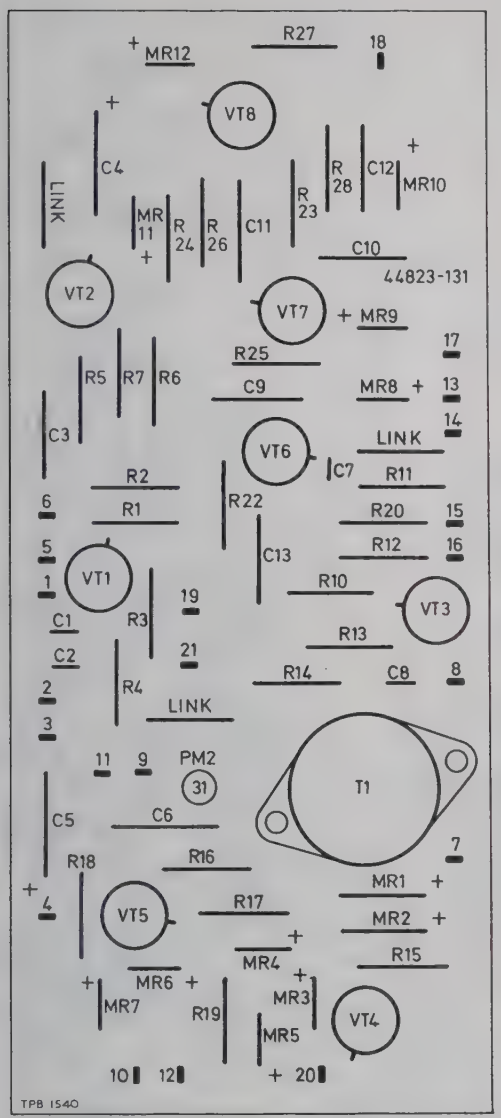


Fig. 5.4 Component location, board 31, marker amplifier

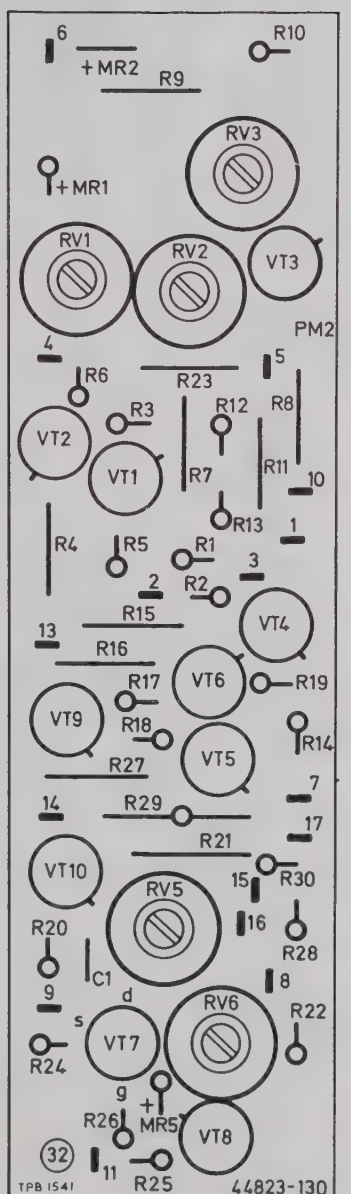


Fig. 5.5 Component location, board 32, a.l.c. amplifier

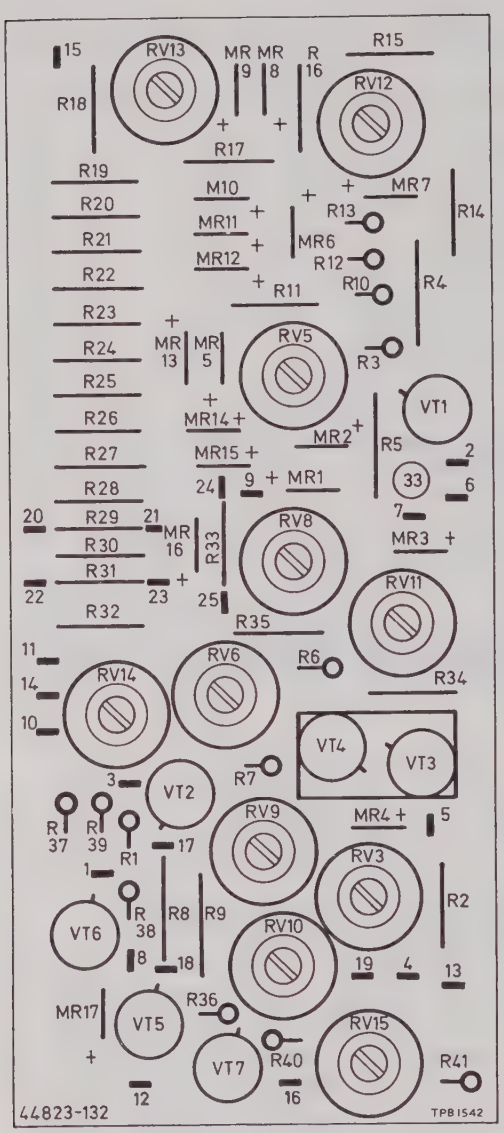
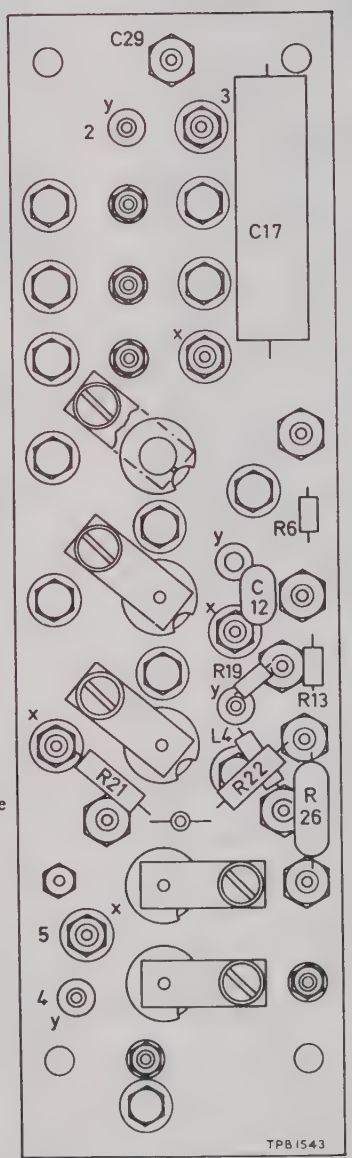


Fig. 5.6 Component location, board 33, distorter and drive



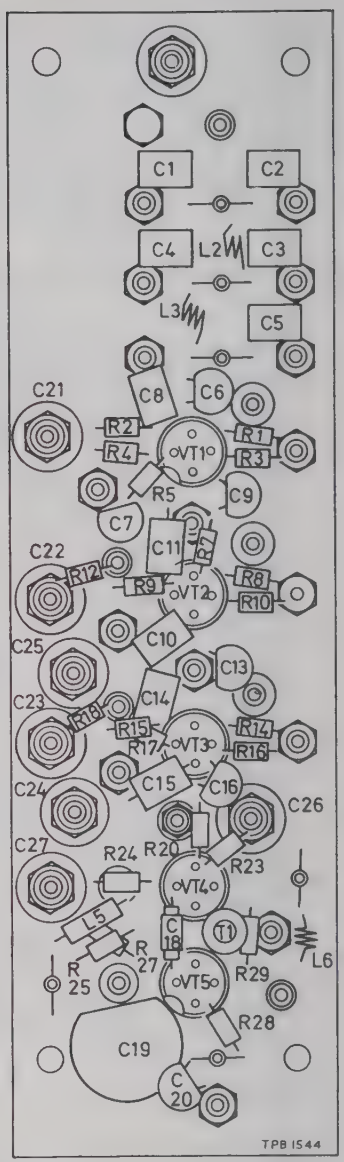


Fig. 5.8 Component location, (bottom), wide band amplifier

Fig. 5.7 Component location, unit 34 (top), wide band amplifier

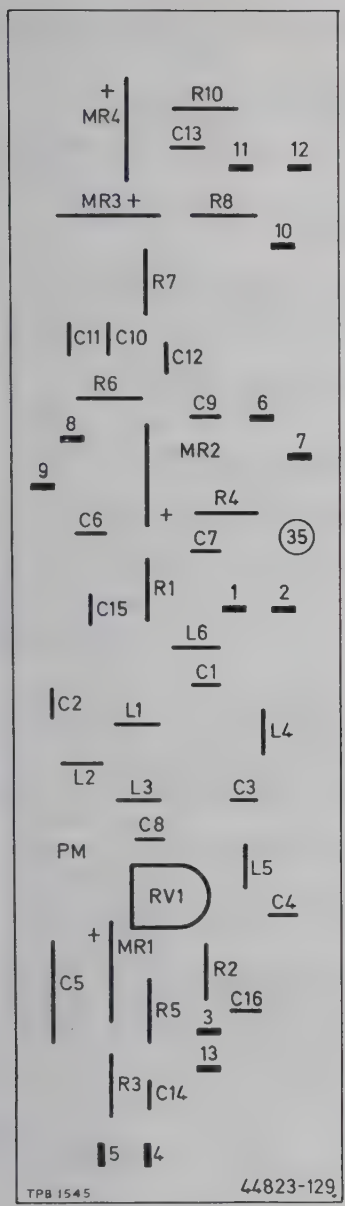


Fig. 5.9 Component location, board 35, marker mixer

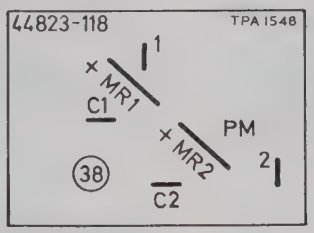


Fig. 5.12 Component location, board 38, level control

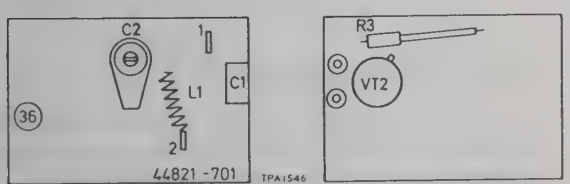


Fig. 5.10 Component location, board 36, fixed oscillator

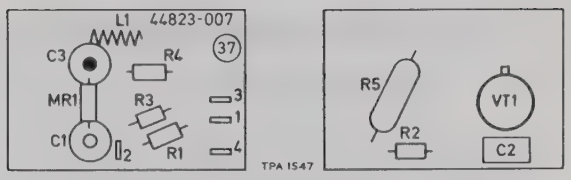


Fig. 5.11 Component location, board 37, swept oscillator

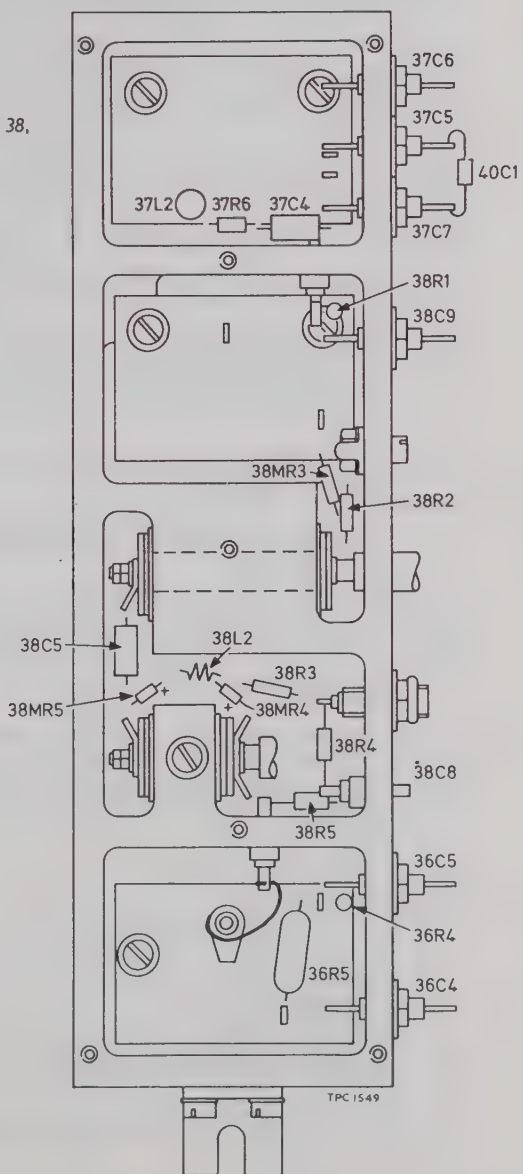


Fig. 5.13 Component location, mixer box

5.6 ADJUSTMENT AND CALIBRATION

5.6.1 Test equipment required

This section provides a list of the test equipment that will be required to carry out the adjustment and calibration procedures detailed in this Chapter. Do not attempt to calibrate the instrument using test equipment having an accuracy less than that of the items recommended. If repair, adjustment or calibration is necessary and adequate test equipment is not available, the instrument should be returned to the manufacturer, where a repair and calibration service is provided.

Item

a) Sweep generator main unit, M.I. TF 2361.

b) Attenuator and frame, M.I. TM 9695.

c) Extension cable assembly, M.I. TM 9912.

d) Connecting link, M.I. 43125-071.

e) Oscilloscope, 5 mV/cm vertical input, D.C. coupled horizontal and vertical inputs, such as M.I. TF 2201 or M.I. TF 2210.

f) Oscilloscope single trace unit for TF 2201, M.I. TM 6970A.

g) Oscilloscope time base unit for TF 2201, M.I. TM 6967.

h) Oscilloscope graticule projector, M.I. TF 8098

i) Oscilloscope graticule, see Fig. 5.14.

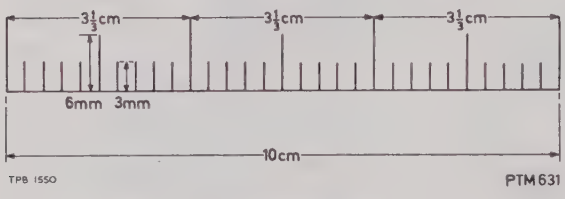


Fig. 5.14 Oscilloscope graticule

j) R.F. voltmeter, M.I. TF 2603.

k) Signal generator, 1 MHz to 300 MHz, such as M.I. TF 801D and TF 144H.

l) A.M./F.M. modulation meter, such as M.I. TF 2300.

m) Counter frequency meter } such as M.I. TM 1417 or

n) Converter } M.I. TF 2400/1

o) Multimeter, 20 kΩ/V, such as Avometer Model 8.

p) R.C. oscillator, such as M.I. TF 1370A.

r) V.H.F./U.H.F. detector, M.I. TM 9701.

s) V.H.F./U.L.F. A.L.C. detector, M.I. TM 9702.

t) Adaptor type N to type N, such as M.I. 23443-781.

u) 50 Ω termination, V.S.W.R. 1.05, such as M.I. 23443-789.

v) T connector, M.I. TM 7948.

w) Backing-off jig, see Fig. 5.15.

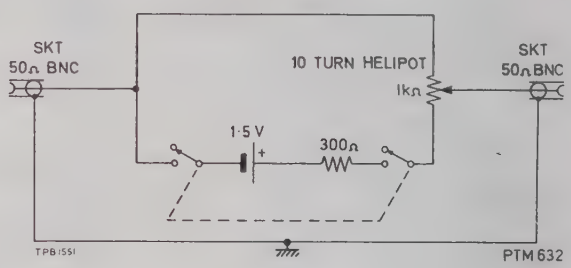


Fig. 5.15 Backing-off jig

y) Unterminated detector, see Fig. 5.16.

z) Cable, 50 Ω, 2 m long, such as Amphenol type RG213/U terminated each end with type N plugs such as Amphenol type UG1185/U.

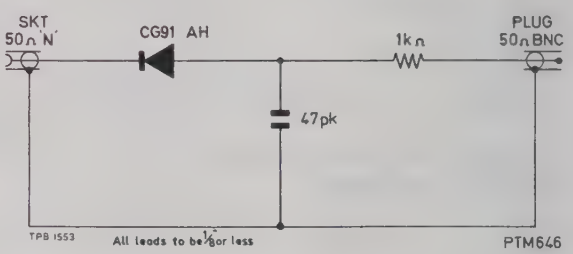


Fig. 5.16 Unterminated detector

5.6.2 Initial conditions

For adjustment and calibration remove the attenuator with the sweep unit from the main unit TF 2361 and fit the extension cable TM 9912. Ensure that the main unit power supplies are OFF while this is being done. Take all necessary precautions to prevent dirt or foreign bodies

entering the unit, and avoid accidental contact with exposed terminals.

Set the front panel controls to the following positions:

(A) Main unit

SUPPLY switch ON.
SWEEP MODE switch at NORMAL.
SWEEP FUNCTION switch at 10 - 100 Hz.
VARIABLE RATE control at mid-position.
RATIO switch at 10:1.
A. L. C. switch at INTERNAL.
MARKER switch ON.
PHASE SHIFT control fully counter-clockwise.
X. DRIVE switch at FORWARD.
X-DRIVE OUTPUT LEVEL fully clockwise.
BLANKING switch ON.
EXTERNAL DRIVE SET LEVEL fully counter-clockwise.

(B) Sweep unit

SWEEP WIDTH switch at WIDE.
SWEEP WIDTH (wide) control fully clockwise.
CENTRE FREQUENCY control at 150 MHz.
FINE CENTRE FREQUENCY control at 0 (mid-position).
MARKER DRIVE and HEIGHT controls at mid-position).
MARKER selector and POLARITY switches at PULSE and +
MARKER FUNCTION switch at 100 MHz.
SWEEP LINEAR switch at LINEAR.
FINE LEVEL switch at CONTINUOUS.
A. L. C. LEVEL control fully clockwise (CAL).
FINE LEVEL control at mid-position (0 dB).
R. F. OUTPUT connected to attenuator unit by U-link.
Attenuator unit: both controls at 0 dB.

5.6.3 Internal markers and initial sweep

Test equipment: (a), (b), (c), (d), (e), (f) (g), (r), (t), (u)

(1) Connect the equipment as shown in Fig. 5.17.

(2) Set the oscilloscope to external time base, horizontal expansion 3/4 fully clockwise and vertical input 0.2 V/cm d.c. coupled. Adjust the X-DRIVE OUTPUT control on the sweep generator so that the trace just fills the graticule. Set the MARKER switch on the sweep unit to BIRDIE.

(3) If the base line of the display is unsteady and the trace moves up and down, adjust the turns of 35L6 on the marker mixer and a.l.c. detector board.

(4) Remove the cover from the marker oscillator board, and adjust 30C3 so that the 100 MHz marker amplitude is at a maximum with no spurious signals or oscillations. Take care not to short out the 1000 pF feed-through capacitor to 30C3. Remove the trimming tool and place the cover against the box to check that this does not alter the adjustment. Note that the sub-harmonics at 50 MHz will be visible.

(5) Check that the 100 MHz markers are present in the 100 + 10 MHz and 100 MHz + EXT positions of the MARKER FUNCTION switch.

(6) Set the MARKER FUNCTION switch to 1 MHz, and adjust 30L5 so that the 1 MHz markers have maximum amplitude with the slug set in the middle of the maximum aplitude range.

(7) Set the MARKER FUNCTION switch to 10 MHz, and adjust 30L4 so that the 10 MHz markers have maximum amplitude with the slug set in the middle

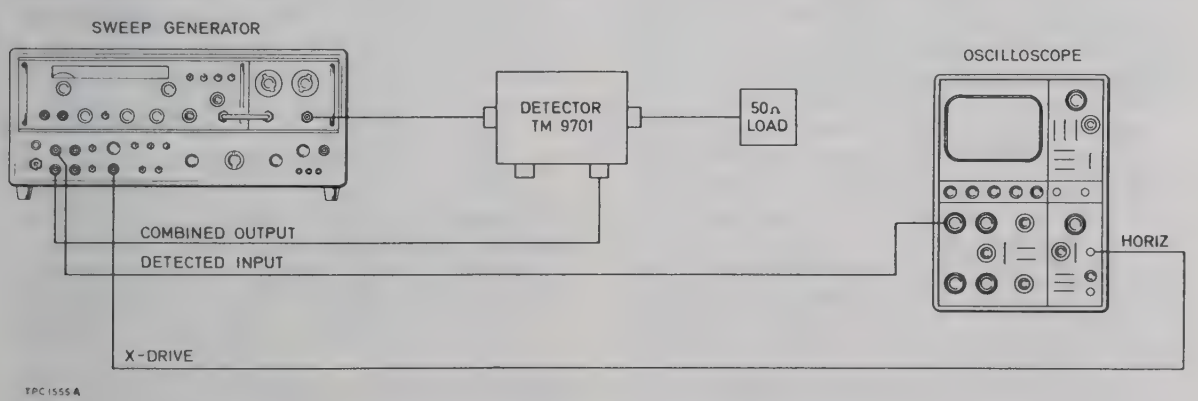


Fig. 5.17 Connection diagram—internal markers and initial sweep

of the range. Note that the 5 MHz sub-harmonics will be visible.

(8) Set the MARKER FUNCTION switch to 1 MHz, the SWEEP WIDTH selector to NARROW and the NARROW SWEEP WIDTH control to mid-position. Adjust 30L4 until the interference from the 10 MHz markers is at a minimum. Replace the cover on board 30.

(9) Set the MARKER switch to PULSE, the MARKER FUNCTION switch to 100 + 10 MHz, and the MARKER DRIVE and HEIGHT controls for optimum marker display.

(10) Remove the cover of the distorter and drive unit, and adjust 33RV3, 33RV8 and 33RV10 in order to set the 0 marker and the 300 MHz marker near the left and right-hand edges of the graticule respectively.

(11) Adjust 32RV2 so that the amplitude of the display from response to base-line is 0.56 V. Replace the cover on board 33.

(12) Check the trace for flatness of response. If there is a sharp dip at the low frequency end of the sweep, set the A. L. C. LEVEL control to uncalibrated and maximum (i.e. just off the switch position). Adjust 38C3 and 38C4 on the mixer box (one adjuster, rearmost from front panel) until the flatness is maintained at all frequencies.

(13) Examine the response for any sharp spikes which change the marker intervals suddenly for the rest of the sweep. If necessary, remove the screwed cover from the mixer box and adjust 38L2 in order to restore the marker interval linearity. Replace the cover and screw down tightly.

(14) Transfer the connection between the detector TM 9701 and the detected input on the main unit from the negative output to the positive output of the detector.

(15) Adjust 38C6 and 38C7 on the mixer box (one adjuster, nearest to the front panel) for best flatness of the response. Adjust the phosphor bronze slug 38L3 as a fine adjustment.

(16) Repeat para. (12).

(17) Set the A. L. C. LEVEL control fully counter-clockwise and check that there are no 'bumps' in the response that are more than one-quarter of the normal total output level. If necessary, adjust 38C3 and 38C4 to reduce them, and then repeat para. (15).

(18) Repeat paras. (12) to (17) until all conditions are satisfied.

5.6.4 Output level

Test equipment: (a), (b), (c), (d), (e), (f), (g), (j), (o), (r), (t), (u), (v) and (w)

(1) Connect the equipment as shown in Fig. 5.18, and set the oscilloscope as in 5.6.3 (2).

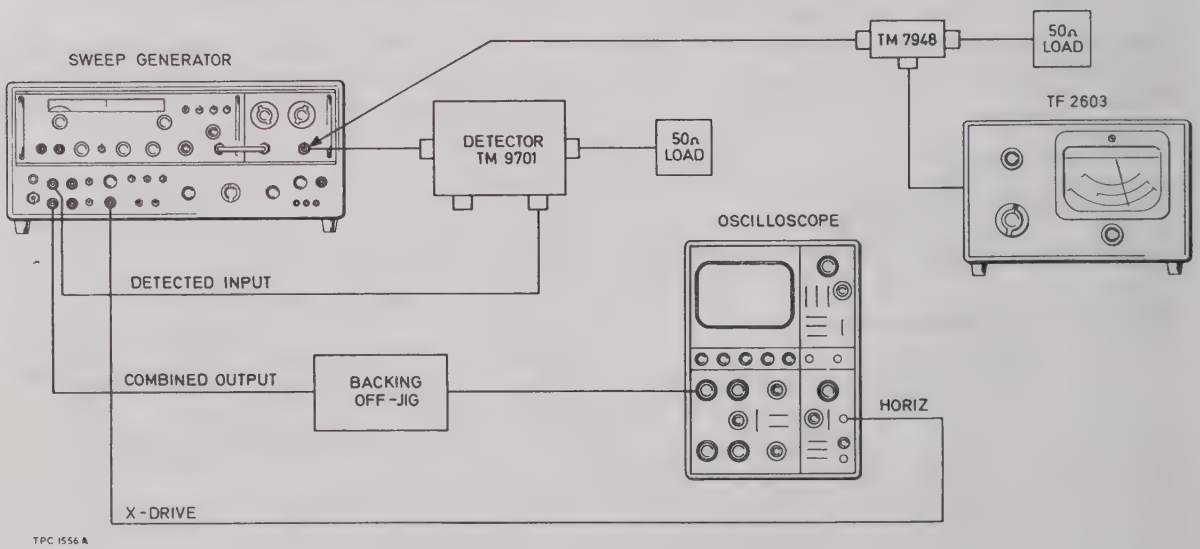


Fig. 5.18 Connection diagram—output level check

(2) Revert to the initial conditions detailed in Sect. 5.6.2, except for the following:

VARIABLE RATE control fully clockwise.
MARKER switch OFF.
MARKER FUNCTION switch at EXT.
MARKER DRIVE and HEIGHT controls fully counter-clockwise.
SWEEP WIDTH selector at NARROW.
SWEEP WIDTH (narrow) control fully clockwise.
CENTRE FREQUENCY control at 100 MHz.

(3) Remove the cover of the a.l.c. amplifier (board 32), and connect the multimeter between terminal 9 and the end of R21 nearest to terminal 9. Adjust 32RV5 for zero meter indication on the 2.5 V d.c. range.

(4) Set the FINE LEVEL switch to ALTERNATE, the oscilloscope sensitivity to 20 mV/cm, and adjust the level of the backing-off jig so that the two traces are visible. Adjust 32RV1 so that the two traces are coincident. Return the FINE LEVEL switch to CONTINUOUS.

(5) Adjust the oscilloscope vertical gain and shift, and the backing-off level, to give a 5 cm change in trace level when 2 dB is switched in and out on the attenuator TM 9695.

(6) Set the FINE LEVEL switch to ALTERNATE and the FINE LEVEL control to +1 dB. Observe the lower of the two traces and set its position to the centre line of the graticule. Switch 1 dB repeatedly in and out on the attenuator while adjusting 32RV3, so that the lower trace at 0 dB is in the same position as the upper trace at 1 dB.

(7) Set the FINE LEVEL control to 0 dB and note the trace position. Switch in 1 dB on the attenuator and adjust the oscilloscope gain and the backing-off level so that a change of 1 dB covers 5 cm on the graticule, then vary the FINE LEVEL control from -1 dB to +1 dB and check that the trace separates by -5 cm to +5 cm ±5 mm (5 mm = 0.1 dB).

(8) Set the FUNCTION switch on the main unit to CW, the FINE LEVEL control to 0 dB and the A.L.C. LEVEL control to CAL. Disconnect the detector TM 9701, and connect the r.f. voltmeter TF 2603 (set to the 1 V range) to the TM 9695 output via the T-connector loaded with 50 Ω. Set the TM 9695 attenuators to 0 dB.

(9) Adjust 32RV2 to give a reading of 0.5 V on the r.f. voltmeter. If 32RV2 was a long way out of adjustment, repeat paras. (5) to (7).

(10) Set the A.L.C. LEVEL control to uncalibrated and maximum, and check that the output level rises to 0.75 V ±10%.

(11) Disconnect the r.f. voltmeter, T-connector and load, and reconnect the detector TM 9701 as in Fig. 5.22. Set the A.L.C. LEVEL control to CAL, the FINE LEVEL control fully clockwise, the SWEEP WIDTH selector and control to WIDE and MAXIMUM, the centre frequency to 150 MHz, the main unit FUNCTION switch to 10 - 100 MHz a and the VARIABLE RATE control fully clockwise.

(12) Adjust the oscilloscope gain so that the complete sweep is displayed. Adjust 32RV6 so that the blanking transient spike at the high frequency end of the sweep is reduced to zero. Check that no spikes appear when the FINE LEVEL control is varied over its full range. Replace the cover on board 32.

5.6.5 Sweep calibration

Test equipment: (a), (b), (c), (d), (e), (f), (g), (h), (i), (k), (r), (t) and (u)

(1) Connect the equipment as shown in Fig. 5.17.

(2) Revert to the initial conditions detailed in Sect. 5.6.2, and set the oscilloscope as in Sect. 5.6.3(2). Adjust the MARKER DRIVE and HEIGHT controls for optimum display, with the 50 MHz sub-harmonics visible. Fit the graticule in the graticule projector, and fit the projector on the oscilloscope.

(3) Remove the cover from the distorter and drive unit, and adjust 33RV15 so that the zero break marker is approximately 0.5 cm from the left-hand edge of the trace. Reduce the centre frequency to zero and adjust 33RV8 until the zero break marker is in the centre of the graticule. Switch to SEMI-LOG and adjust 33RV11 so that the zero break marker is in the centre of the graticule. Repeat the adjustments for both linear and semi-log sweep until the zero break marker remains central on both sweeps. If either 33RV8 or 33RV11 cannot be set as required, make a slight adjustment on 33RV9 or 33RV15.

(4) Connect the signal generator to the EXTERNAL MARKER INPUT socket, and set it at 300 MHz, 200 mV p-p output. Set the MARKER FUNCTION switch to 100 MHz + EXT marker to birdie, and the centre frequency to 300 MHz (linear sweep). Adjust 33RV10 until the 300 MHz marker, which will be distinctive because it will be combined with

the external marker, is in the centre of the graticule. Make the same adjustment with 33RV6 for the semi-log sweep, and repeat the two adjustments until the 300 MHz marker remains central for both linear and semi-log sweeps. If either 33RV or 33RV6 cannot be set as required, make a slight adjustment on 33RV9.

(5) Repeat paras. (3) and (4) after the sweep generator has been switched on for two hours.

(6) Set the sweep width to maximum. Adjust 33RV3 to give a total sweep coverage of 330 MHz, for example from 10 MHz below zero to 20 MHz above 300 MHz. Then adjust 33RV5 to equalize the sweep below zero and above 300 MHz, i.e. from -15 MHz to +315 MHz.

(7) Use the oscilloscope horizontal shift and horizontal expansion controls to line up the 0 and 300 MHz markers with the end lines on the special graticule. Adjust 33RV14 so that the 150 MHz marker coincides with the centre line of the graticule. Check the closeness of the 50 MHz, 100 MHz, 200 MHz and 250 MHz markers to the corresponding graticule lines, and if necessary adjust 33RV12 and 33RV13, then re-check the setting of 33RV14. If the linearity cannot be set so that the discrepancies are less than 5 MHz, adjust 33RV15 or 33RV15 or 33RV9 and repeat paras. (3) to (6).

(8) Reduce the sweep width to 20 MHz and observe the 150 MHz marker with the centre frequency set to 150 MHz. Check that it is within 1 cm of the centre line of the graticule. If it is outside this limit, the selected resistor 33R8 must be changed; suggested values are 500 kΩ (1 cm correction), 220 kΩ (2 cm correction) or 110 kΩ (3 cm correction). If 33R8 has to be changed, all the adjustments in this section must be repeated. Replace the cover on unit 33.

5.6.6 Spurious responses

Test equipment: (a), (b), (c), (d), (e), (f), (g), (r), and (t)

(1) Connect the equipment as shown in Fig. 5.17, and set the oscilloscope as detailed in Sect. 5.6.3(2).

(2) Revert to the initial conditions detailed in Sect. 5.6.2, except for the following:

MARKER FUNCTION switch at EXTERNAL
MARKER DRIVE and HEIGHT controls fully counter-clockwise.

(3) Adjust the X-DRIVE OUTPUT control so that the trace just fills the graticule, and check the detected response for a sharp spike around 220 MHz to 250 MHz. If this spike is present it can be reduced to less than 0.1 dB (measured as described in Sect. 5.6.7) by adjusting the turns on 35L6, 35L1 and 35L2, and possible 35L3, 35L4 and 35L5.

5.6.7 Detected system flatness

Test equipment: (a), (b), (c), (d), (e), (f), (g), (r), (u) and (w)

(1) Connect the equipment as shown in Fig. 5.19, and set the oscilloscope to external time base, horizontal expansion 3/4 fully clockwise, vertical input 0.2 V/cm d.c. coupled.

(2) Revert to the initial conditions detailed in Sect. 5.6.2, except for the following:

MARKER switch OFF.
MARKER FUNCTION switch at EXTERNAL.
MARKER DRIVE and HEIGHT controls fully counter-clockwise.

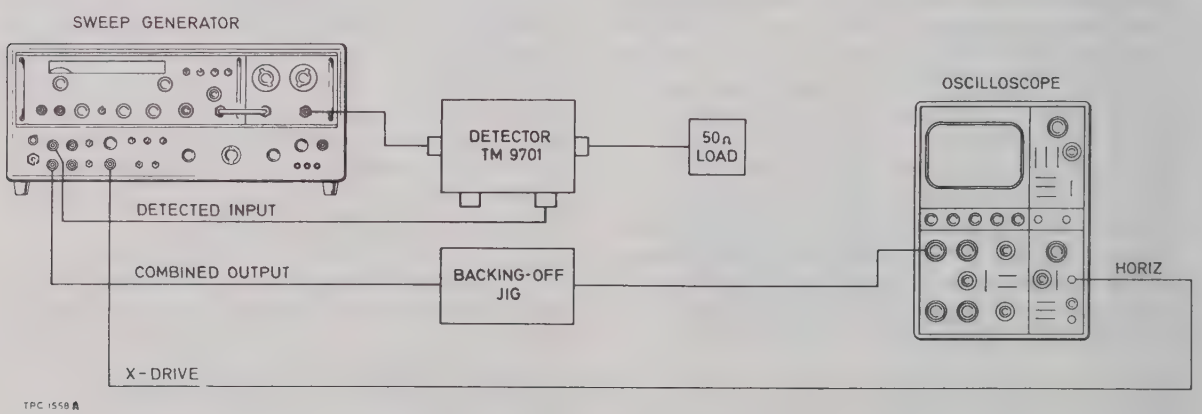


Fig. 5.19 Connection diagram—detected system flatness

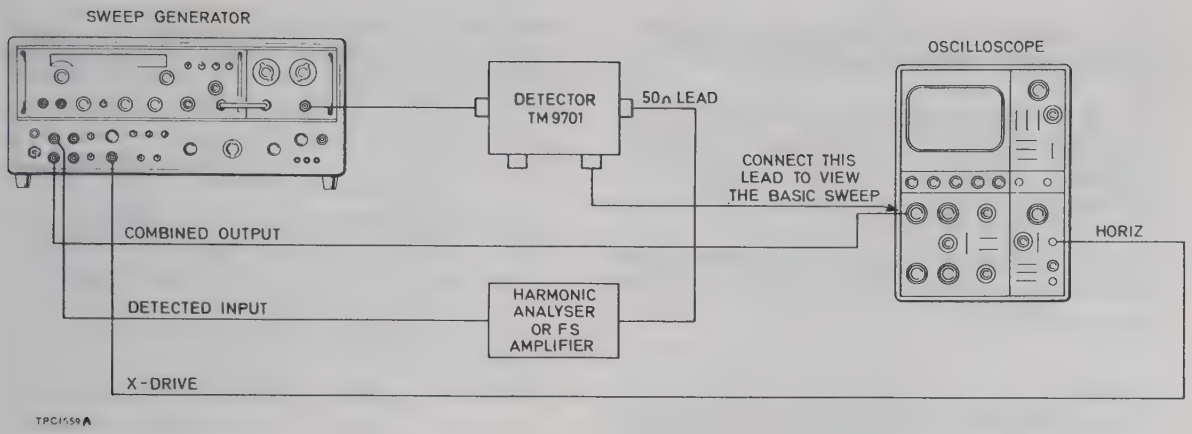


Fig. 5.20 Connection diagram—harmonic distortion check

(3) Adjust the X-DRIVE OUTPUT control so that the trace just fills the graticule, and note the level of the trace. Switch in 1 dB on the fine attenuator and adjust the oscilloscope gain and the backing-off level so that 1dB occupies 5 cm on the graticule.

(4) Remove the cover from the marker mixer and a.l.c. detector (board 35), and adjust 35RV1 so that the response is flat within ±0.2 dB i.e. within a 2 cm excursion on the graticule. Replace the cover and re-check the flatness of the response, re-adjusting 35RV1 to compensate for the effect of the cover, if necessary.

5.6.8. Harmonic distortion and spurious signals

Test equipment: (a), (b), (c), (d), (e), (f), (g), (r) and (t)

Spectrum analyser or frequency selective amplifier.

(1) Connect the equipment as shown in Fig. 5.20, and set the oscilloscope as detailed in Sect. 5.6.3(2).

(2) Revert to the initial conditions detailed in Sect. 5.6.2, except for the following:

SWEEP WIDTH selector at NARROW.
SWEEP WIDTH (narrow) control at 9 o'clock position.
CENTRE FREQUENCY control at 0.
SWEEP FUNCTION switch at 1 - 10 Hz.
VARIABLE RATE control at 3 o'clock position.
MARKER FUNCTION switch at EXTERNAL.
MARKER DRIVE and HEIGHT controls fully counter-clockwise.

(3) Checks on harmonic distortion cannot be made without a spectrum analyser, or a special frequency selective amplifier, free of harmonics, tuned to 6, 10, 20, 40, 75, 100, 150, 200, 260, 300, 400, 600 and 900 MHz. Only general guidance is given here on the method of making harmonic distortion checks; detailed instructions can be obtained from the manufacturer, if required.

(4) Set the oscilloscope sensitivity to 0.2 V/cm, the selected frequency to 6 MHz, and adjust the CENTRE FREQUENCY and FINE CENTRE controls to obtain a display as shown in Fig. 5.21. The response at C represents the fundamental of the swept output at 6 MHz, while those at A and B represent the 3rd and 2nd harmonics of 2 and 3 MHz respectively. The response at D is a spurious signal and is not related to A, B and C.

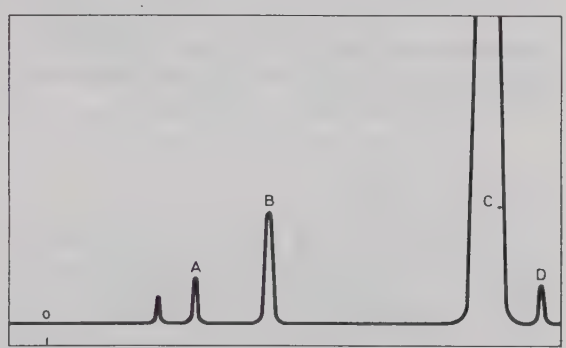


Fig. 5.21 Display for harmonic distortion check

(5) Increase the attenuation on the attenuator TM 9695, until C is the same amplitude as B was previously without attenuation. The attenuation in dB is then the ratio between the second harmonic and the fundamental. In all cases the harmonics should be better than 30 dB down; if they are not, make a slight adjustment to C3 and C4 on the mixer box (control farthest from the front panel). It may also be necessary to make a slight adjustment to the phosphor bronze slug associated with this control.

(6) Repeat paras. (4) and (5) for each of the selected frequencies mentioned in para. (3).

(7) If the mixer box control has to be adjusted to improve the harmonic distortion, it will be necessary to repeat the checks detailed in Sect. 5.6.3 para. (12).

(8) At each test frequency, note the level of the spurious signals; in each case they should be more than 30 dB down.

5.7 REPLACEMENT OF SCALE DRIVE AND INTERLOCK CORDS

5.7.1 Preparation

(1) Remove the front panel knobs from the SWEEP WIDTH and CENTRE FREQUENCY controls (4 BA hexagon socket head grub screws).

(2) Remove the three 6 BA screws securing the drive and potentiometer assembly to the front panel, slacken the screws securing the front panel to the chassis framework, and lift out the scale and drive assembly clear of the chassis. Take care not to strain the potentiometer leads.

(3) Remove broken ends of nylon cord.

(4) Referring to Fig. 5.22, set potentiometer A fully clockwise and potentiometer B to its mid-position (established by checking resistance with a multimeter). Ensure that the three interlocking pins at G are in contact, as shown.

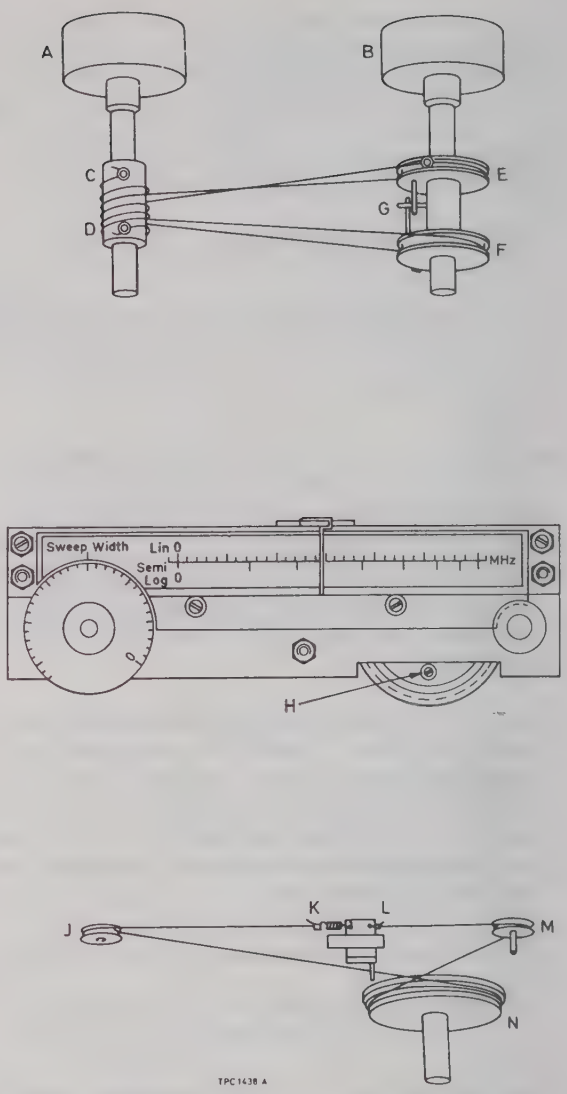


Fig. 5.22 Replacement of scale drive and interlock cords

5.7.2 Interlock cord

(1) Fix one end of the nylon cord under the 8 BA screw C, and make $1\frac{1}{2}$ turns on the drum C-D. Keep the cord tight at all times while it is being fitted. From the bottom of drum C-D take the cord to the top of drum E and pass it half a turn round to the bottom of the drum. From the bottom of drum E go to the top of drum C-D and pass the cord $2\frac{1}{2}$ times round drum C-D, finishing at the bottom. From the bottom of drum C-D go to the bottom of drum F, take $\frac{1}{2}$ turn round drum F to the top, and pass the cord back to the top of drum C-D, make one complete turn on drum C-D and secure it under the 8 BA screw D.

(2) Ensure that drum pins are either side and in contact with central pin as shown at point G. Then tighten down 8 BA screws on drums E and F to trap wire. Reset drive assembly as para. 5.8.4.

5.7.3 Scale drive cord

(1) The length of nylon drive cord to be used as a replacement must be prestretched with a 4 lb weight for 24 hours before use.

(2) Slacken the two grub screws securing gear wheel N, and move the gear wheel round until the screw H is accessible through the cut-out section of the scale plate. Tighten the grub screws securing gear wheel N. (Potentiometers to be set as in 5.7.1(4).)

(3) Pass the centre of the nylon cord through the hole in the drum opposite screw H, and secure this loop under screw H. Then take one end of the cord and make $1\frac{1}{2}$ turns round drum N in a clockwise direction as viewed from the front.

(4) From the top of drum N take the cord round pulley M (from bottom to top) and secure it to the pointer carriage by passing it through the hole L in the carriage and fixing it with a ferrule. The carriage must be positioned so that the pointer is at the centre of the scale, i.e. at 150 MHz.

(5) Take the other end of the nylon cord and make $1\frac{1}{2}$ turns round drum N in a counter-clockwise direction as viewed from the front, then from the top of drum N go round pulley J (from bottom to top) and secure the cord to the spring K by fastening it with a ferrule, so that the spring is extended by approximately 1/8 inch (3.3 mm). Reset drive assembly as para. 5.7.5.

5.7.4 Replacement of potentiometers

(1) To remove a potentiometer unscrew the 3/8 inch nut and slacken the two 8 BA hexagon socket head grub screws in the brass collar just enough to free the spindle. Further withdrawal of the grub screws will upset the alignment of the collar and primary spindle.

(2) To replace potentiometer A, set the potentiometer fully clockwise and set the left-hand drive spindle fully clockwise, ensuring that the three interlocking pins at G are in contact as shown. Insert the potentiometer spindle fully into the hole without rotating. Retighten 3/8 inch nut and both grub screws. Reset drive assembly as para. 5.7.5.

(3) To replace potentiometer B, set the potentiometer to mid position and set the left-hand drive spindle fully clockwise, ensuring that the three interlocking pins at G are in contact as shown. Insert the potentiometer spindle fully into the hole without rotating. Retighten the 3/8 inch nut and both grub screws. Reset drive assembly as para. 5.7.5.

5.7.5 Dial and pointer settings

(1) Ensure that the potentiometers and interlocking pins are set as described in para. 5.7.1(4), slacken the screws holding drum N, and move the drum slightly until the pointer is exactly on the 150 MHz mark on the linear scale. Retighten the screws securing drum N.

(2) Rotate the right-hand spindle (potentiometer B) until the pointer is on the 0 mark on the linear scale. Slacken the screws securing the circular dial (left-hand spindle) and rotate the dial until the second graduation (20 MHz) and the sweep width indicator line are together, with the two interlock pins still in contact. Retighten the screws.

(3) Rotate the right-hand spindle further counter-clockwise until the dial indicates zero. Slacken the 3/8 inch nut securing the left-hand potentiometer, and using a multimeter on the ohms range, rotate the body of the potentiometer until it is just on its electrical zero, ensuring that the two interlock pins remain in contact. Tighten the nut carefully without disturbing the setting.

(4) Rotate the right-hand spindle clockwise until the pointer indicates 150 MHz on the linear scale, check that the three interlocking pins are in contact, and check that the dial indication is greater than 300.

(5) Rotate the right-hand spindle clockwise until the pointer indicates 300 MHz on the linear scale, check that the two interlocking pins are in contact, and check that the dial indication is approximately 20. Refit the drive assembly into the sweep unit.

5.8 FAULT FINDING

Fault finding techniques should follow standard electronic practice, and in this chapter only general guidance if given on some typical faults. Voltages are shown on the circuit diagrams at the end of this handbook, as an aid to fault finding.

(1) No r.f. output. Examine the marker output, and if this is correct suspect a fault between the 50 Ω source resistor on the a.l.c. detector board and the attenuator output.

(2) Low r.f. output. Switch to external a.l.c., and if the unlevelled output rises beyond the specified maximum suspect a fault in the a.l.c. amplifier or reference circuit.

(3) Low r.f. output with irregular dips. Switch to external a.l.c., and if the dips follow a similar pattern suspect low forward loop gain, e.g. faulty wide band amplifier or mixer.

(4) No marker output, no r.f. output. Examine monitor output on main unit, and if correct suspect a failure in the fixed oscillator, swept oscillator or wide band amplifier.

(5) Monitor waveform incorrect. Suspect fault or maladjustment in distorter and drive unit.

(6) No pulse marker. Check birdie markers, and if correct suspect a fault in the detector and pulse shaping circuit on the marker amplifier board.

(7) No birdie markers. Check external marker facility. If operative suspect fault in marker oscillator/harmonic generator board. If inoperative suspect marker mixer or marker amplifier.

(8) 1, 10 or 100 MHz markers missing. Suspect fault in relevant marker oscillator on marker oscillators board.

(9) High distortion content in r.f. output. Examine the flatness of both the positive and negative detected outputs, and if only one of these is distorted suspect maladjustment of the mixer low pass or tuned filters, or a fault in the wide band amplifier.

(10) No alternate trace facility. Check the blanking input to the bistable circuit, and if this is correct suspect a fault in the bistable.

(11) No blanking. Check the blanking generator and its connections in the main unit, and if faulty refer to the main unit handbook.

(12) Reduced sweep width. Examine the monitor output on the main unit, and if correct suspect that the swept oscillator is not covering its full range. Check this using a wavemeter with the sweep generator in the c.w. mode.

(13) Zero break not on edge of sweep. Suspect the fixed oscillator out of alignment (re-tune to 1000 MHz), or the swept oscillator not covering its full range, or maladjustment in the distorter and drive unit.

(14) Lack of flatness in detected output. Check detector and lead by substitution, and if correct suspect a fault in the a.l.c. amplifier, detector or modulator.

(15) Non-linearity over full sweep. Examine the monitor output on the main unit, and if correct suspect a faulty varactor in the swept oscillator.

(16) High residual f.m. Examine the monitor output under c.w. conditions, and if excessive noise or ripple is present suspect a fault in the distorter and drive unit. Decouple pin 16 on the distorter and drive unit to conform.

Chapter 6

Replaceable parts

Introduction

This chapter lists replaceable parts in alphabetical order of their circuit references, and in the order of the sub-assembly and printed circuit board numbers, as follows:

28 : Fine attenuator } not available separately,
29 : Coarse attenuator } only as TM 9695
30 : Marker oscillators
31 : Marker amplifier
32 : A.L.C. amplifier
33 : Distorter and drive unit
34 : Wide band amplifier
35 : Marker mixer and a.l.c. detector
36 : Fixed oscillator
37 : Swept oscillator
38 : Level control and mixer
40 : Sweep unit chassis and front panel

When ordering parts or referring to them in correspondence, use the board number to prefix the circuit reference number, for example 30R1, 38MR5. The following abbreviations are used in the list of replaceable parts:

C : capacitor
Carb : carbon
Cer : ceramic
Elec : electrolytic
L : inductor
Lin : linear
Met : metal film
MR : semiconductor diode
PL : plug
Plas : plastic
R : resistor
RV : variable resistor
S : switch
SKT : socket
T : transformer
VT : transistor
W : watts at 70°C
WW : wirewound
XL : crystal
Ø : feed-through component
† : value selected during test: nominal value shown

Ordering

Send your order for replaceable parts to our Service Division at the address given on the back cover. Specify the following information for each part required:

1. Type and serial number of instrument
2. Circuit reference
3. Description
4. M.I. code number

If a part is not listed, state its function, location and description when ordering.

Circuit reference	*Description*	*M.I. code*
Unit (28) fine attenuator		
When ordering, prefix circuit reference with 28		
R1	Met 150Ω 1% ¼W	24636-613
R2	Met 37.3Ω 1% ¼W	24636-224
R3	Met 150Ω 1% ¼W	24636-613
R4	Met 292Ω 1% ¼W	24636-710
R5	Met 17.6Ω 1% ¼W	24636-109
R6	Met 292Ω 1% ¼W	24636-710
R7	Met 870Ω 1% ¼W	24636-905
R8	Met 5.77Ω 1% ¼W	24636-032
R9	Met 870Ω 1% ¼W	24636-905
R10	Met 436Ω 1% ¼W	24636-711
R11	Met 11.6Ω 1% ¼W	24636-113
R12	Met 436Ω 1% ¼W	24636-711
R13	Met 96.3Ω 1% ¼W	24636-494
R14	Met 71.2Ω 1% ¼W	24636-368
R15	Met 96.3Ω 1% ¼W	24636-494

Circuit reference	Description	M.I. code
SKT1	Type N, GE15077	23443-739
SKT2	Type N, GE15033	23443-738

Unit (29) coarse attenuator

When ordering, prefix circuit reference with 29

R1	Met 71.6Ω 0.5% ¼W	24634-359
R2	Met 136Ω 0.5% ¼W	24634-614
R3	Met 71.6Ω 0.5% ¼W	24634-359
R4	Met 71.6Ω 0.5% ¼W	24634-359
R5	Met 136Ω 0.5% ¼W	24634-614
R6	Met 71.6Ω 0.5% ¼W	24634-359
R7	Met 96.3Ω 1% ¼W	24636-494
R8	Met 71.2Ω 1% ¼W	24636-368
R9	Met 96.3Ω 1% ¼W	24636-494
R10	Met 96.3Ω 1% ¼W	24636-494
R11	Met 71.2Ω 1% ¼W	24636-368
R12	Met 96.3Ω 1% ¼W	24636-494
R13	Met 96.3Ω 1% ¼W	24636-494
R14	Met 71.2Ω 1% ¼W	24636-368
R15	Met 96.3Ω 1% ¼W	24636-494
SKT1	Type N, GE15077	23443-739
SKT2	Type N, GE15033	23443-738

Unit (30) marker oscillator

When ordering, prefix circuit reference with 30

Complete board		44827-102
C1	Cer 0.001μF +40-20% 500V	26383-242
C2	Cer 0.001μF +40-20% 500V	26383-242
C3	Variable 2pF - 9.3pF 750V	26817-235
C4	Cer 33pF 5% 750V	26324-822
C5	Cer 15pF ±0.25pF 750V	26324-712
C7	Cer 6.8pF ±0.25pF 750V	26324-706
C8	Cer 68pF 2% 750V	26324-868
C9	Cer 68pF 2% 750V	26324-868
C10	Cer 0.001μF +40-20% 500V	26383-242
C11	Cer 6.8pF ±0.25pF 750V	26324-706
C12	Cer 6.8pF ±0.25pF 750V	26324-706
C13	Plas 0.1μF 10% 250V	26512-228
C14	Cer 33pF 5% 750V	26324-822
C15	Plas 200pF 2% ~~125V~~ 350V	26516-~~315~~ 318
C16	Plas 100pF 2% ~~125V~~ 350V	26516-~~241~~ 243
C17	Cer 0.01μF +80-20% 100V	26383-055
C18	Cer 0.1μF +50-25% 30V	26383-031
C19	Cer 0.01μF +80-20% 100V	26383-055
C20	Plas 0.001μF 2% ~~125V~~ 350V	26516-~~481~~ 1284
C21	Plas 0.002μF 2% 125V	26516-556
C22	Cer 33pF 5% 750V	26324-822
C23	Plas 0.1μF 10% 250V	26512-228
C24	Cer 0.1μF +50-25% 30V	26383-031
C25	Cer Ø 0.0047μF +80-20% 500V	26373-665
C26	Cer Ø 0.0047μF +80-20% 500V	26373-665
C27	Cer Ø 0.001μF +80-20% 500V	26373-714
C28	Cer Ø 0.0047μF +80-20% 500V	26373-665
C29	Cer 0.01μF +80-20% 100V	26383-055
C30	Cer 0.01μF +80-20% 100V	26383-055
L1	Inductor	35124-~~132~~ 422
L2	Inductor	35124-135
L3	Part of printed board	31827-102
L4	Inductor	44235-204
L5	Inductor	44263-601
L6	Inductor	35124-421
L7	Inductor	35124-142
XL1	100MHz	28311-915

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
XL2	10MHz	28311-904
XL3	1MHz	28311-914
MR1	HG1005	28323-035
MR2	1S44	28357-548
MR3	1S44	28357-548
MR4	1N914	28336-676
MR5	1S44	28357-548
MR6	1N914	28336-676
MR7	1S44	28357-548
R1	Carb 15kΩ 5% ¼W	24312-914
R2	Carb 7.5kΩ 5% ¼W	24312-907
R3	Carb 330Ω 5% ¼W	24312-863
R4	Carb 560Ω 5% ¼W	24312-872
R7	Carb 2.2kΩ 5% ½W	24313-888
R8	Carb 22kΩ 5% ¼W	24312-918
R9	Carb 1kΩ 5% ¼W	24312-880
R10	Carb 1kΩ 5% ¼W	24312-880
R11	Carb 1kΩ 5% ¼W	24312-880
R12	Carb 220Ω 5% ¼W	24312-858
R13	Carb 4.7kΩ 5% ¼W	24312-900
R14	Carb 1MΩ 5% ¼W	24312-966
R15	Carb 2.2kΩ 5% ¼W	24312-888
R16	Carb 10kΩ 5% ¼W	24312-910
R17	Carb 470Ω 5% ¼W	24312-869
R18	Carb 220Ω 5% ¼W	24312-858
R19	Carb 10kΩ 5% ¼W	24312-910
R20	Carb 47kΩ 5% ¼W	24312-926
R21	Carb 150kΩ 5% ¼W	24312-939
R22	Carb 150kΩ 5% ¼W	24312-939
R23	Carb 47kΩ 5% ¼W	24312-926
R24	Carb 18kΩ 5% ¼W	24312-916
R25	Carb 220Ω 5% ¼W	24312-858
R26	Carb 470Ω 5% ¼W	24312-869
R27	Carb 10kΩ 5% ¼W	24312-910
R28	Carb 2.2kΩ 5% ¼W	24312-888
R29	Carb 10kΩ 5% ¼W	24312-910
R30	Carb 15kΩ 5% ¼W	24312-914
R31	Carb 220Ω 5% ¼W	24312-858
R32	Carb 50Ω 5% ¼W	24511-538
SKT1	Type S, GE65006	23443-889
VT1	BSX20	28452-197
VT2	BSX20	28452-197
VT3	BFW16	28453-617
VT4	BCY72	28433-487
VT5	BCY72	28433-487
VT6	BSX20	28452-197
VT7	BSX20	28452-197
VT8	BCY72	28433-487
VT9	BCY72	28433-487
VT10	BCY72	28433-487

Unit (31) marker amplifier

When ordering, prefix circuit reference with 31

Complete board		44823-131
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Paper 220pF 20% 600V	26174-118
C4	Elec 1μF +100-20% 50V	26414-106
C5	Elec 1μF +100-20% 50V	26414-106
C6	Elec 1μF +100-20% 50V	26414-106
C7	Cer 0.01μF +80-20% 100V	26383-055
C8	Cer 0.001μF +40-20% 500V	26383-242
C9	Paper 0.02μF 10% 200V	26174-151

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C10	Paper 0.01μF 10% 200V	26174-145
C11	Paper 0.02μF 10% 200V	26174-151
C12	Paper 0.01μF 10% 200V	26174-145
C13	Paper 300pF 20% 600V	26174-119
MR1	1N914	28336-676
MR2	1N914	28336-676
MR3	1S44	28357-548
MR4	1S44	28357-548
MR5	1S44	28357-548
MR6	1S44	28357-548
MR7	1S44	28357-548
MR8	1S44	28357-548
MR9	1S44	28357-548
MR10	1S44	28357-548
MR11	1S44	28357-548
MR12	1S44	28357-548
R1	Carb 47kΩ 5% ¼W	24312-926
R2	Carb 22kΩ 5% ¼W	24312-918
R3	Carb 220Ω 5% ¼W	24312-858
R4	Carb 10kΩ 5% ¼W	24312-910
R5	Carb 100Ω 5% ¼W	24312-850
R6	Carb 68kΩ 5% ¼W	24312-931
R7	Carb 22kΩ 5% ¼W	24312-918
R10	Carb 47kΩ 5% ¼W	24312-926
R11	Carb 47kΩ 5% ¼W	24312-926
R12	Carb 3.3kΩ 5% ¼W	24312-894
R13	Carb 100Ω 5% ¼W	24312-850
R14	Carb 2kΩ 5% ¼W	24312-887
R15	Carb 10kΩ 5% ¼W	24312-910
R16	Carb 430Ω 5% ¼W	24312-867
R17	Carb 22kΩ 5% ¼W	24312-918
R18	Carb 1kΩ 5% ¼W	24312-880
R19	Carb 1kΩ 5% ¼W	24312-880

Circuit reference	Description	M.I. code
R20	Carb 10kΩ 5% ¼W	24312-910
R21	Not used	
R22	Carb 220kΩ 5% ¼W	24312-943
R23	Carb 10kΩ 5% ¼W	24312-910
R24	Carb 2.2kΩ 5% ¼W	24312-888
R25	Carb 6.8kΩ 5% ¼W	24312-906
R26	Carb 6.8kΩ 5% ¼W	24312-906
R27	Carb 2.2kΩ 5% ¼W	24312-888
R28	Carb 10kΩ 5% ¼W	24312-910
T1	Transformer	43541-010
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3	BCY70	28434-857
VT4	BFY51	28455-827
VT5	BCY70	28434-857
VT6	BCY70	28434-857
VT7	BCY70	28434-857
VT8	BCY70	28434-857

Unit (32) a.l.c. amplifier

When ordering, prefix circuit reference with 32

	Complete board	44823-130
C1	Cer 33pF 5% 750V	26324-822
MR1	1S44	28357-548
MR2	1S44	28357-548
MR3	Not used	
MR4	Not used	
MR5	1S44	28357-548

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R1	Carb 4.7kΩ 5% ¼W	24312-900
R2	Carb 470Ω 5% ¼W	24312-869
R3	Carb 1kΩ 5% ¼W	24312-880
R4	Carb 1kΩ 5% ¼W	24312-880
R5	Carb 4.7kΩ 5% ¼W	24312-900
R6	Carb 470Ω 5% ¼W	24312-869
R7	Carb 1.5kΩ 5% ¼W	24312-884
R8	Carb 10kΩ 5% ¼W	24312-910
R9	Carb 5.6kΩ 5% ¼W	24312-903
R10	Carb 22kΩ 5% ¼W	24312-918
R11	Carb 20kΩ 5% ¼W	24312-917
R12	Carb 15kΩ 5% ¼W	24312-914
R13	Carb 10kΩ 5% ¼W	24312-910
R14	Carb 1.2kΩ 5% ¼W	24312-882
R15	Carb 22kΩ 5% ¼W	24312-918
R16	Carb 18kΩ 5% ¼W	24312-916
R17	Carb 100Ω 5% ¼W	24312-850
R18	Carb 100Ω 5% ¼W	24312-850
R19	Carb 120kΩ 5% ¼W	24312-937
R20	Carb 10kΩ 5% ¼W	24312-910
R21	Carb 33kΩ 1% ¼W	24135-330
R22	Carb 100Ω 5% ¼W	24312-850
R23	Carb 2.7kΩ 5% ¼W	24312-892
R24	Carb 1MΩ 5% ¼W	24312-966
R25	Carb 3.3kΩ 5% ¼W	24312-894
R26	Carb 22kΩ 5% ¼W	24312-918
R27	Carb 47kΩ 5% ¼W	24312-926
R28	Carb 47kΩ 5% ¼W	24312-926
R29	WW 1kΩ 5% 1½W	25123-080
R30	Carb 2.2kΩ 5% ½W	24313-888
RV1	WW 470Ω 10% 1W lin.	25811-017
RV2	Carb 22kΩ 20% ¼W lin.	25611-080
RV3	Carb 22kΩ 20% ¼W lin.	25611-080
RV4	Not used	
RV5	WW 4.7kΩ 10% 1W lin.	25811-023
RV6	Carb 10kΩ 20% ¼W lin.	25611-078
VT1	BCY70	28434-857
VT2	BCY70	28434-857
VT3	BC109	28452-777
VT4	BC109	28452-777
VT5	BC109	28452-777
VT6	BCY70	28434-857
VT7	MPF104	28459-001
VT8	BCY70	28434-857
VT9	BC109	28452-777
VT10	BC109	28452-777

Unit (33) distorter and drive

When ordering, prefix circuit reference with 33

Complete board		44823-132
MR1	1S923	28356-018
MR2	1S923	28356-018
MR3	1S923	28356-018
MR4	1S923	28356-018
MR5	1S923	28356-018
MR6	1S923	28356-018
MR7	1S923	28356-018
MR8	1S923	28356-018
MR9	1S923	28356-018
MR10	1S923	28356-018
MR11	1S923	28356-018
MR12	1S923	28356-018
MR13	1S923	28356-018
MR14	1S923	28356-018
MR15	1S923	28356-018
MR16	1S923	28356-018
MR17	1S923	28356-018
R1	Carb 75kΩ 5% ¼W	24312-932
R2	Carb 27kΩ 5% ¼W	24312-920

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R3	Carb 3.6kΩ 5% ¼W	24312-895
R4	Carb 1.2kΩ 1% ¼W	24134-120
R5	Carb 1kΩ 1% ¼W	24134-100
R6	Carb 39kΩ 5% ¼W	24312-924
R7	Carb 10kΩ 5% ¼W	24312-910
R8 †	Carb 430kΩ 5% ¼W	24312-951
R9	Carb 1.8kΩ 1% ¼W	24134-180
R10	Carb 430Ω 5% ¼W	24312-867
R11	Carb 10kΩ 5% ¼W	24312-910
R12	Carb 75Ω 5% ¼W	24312-844
R13	Carb 20kΩ 5% ¼W	24312-917
R14	Carb 110Ω 5% ¼W	24312-851
R15	Carb 160Ω 5% ¼W	24312-855
R16	Carb 39kΩ 5% ¼W	24312-924
R17	Carb 270Ω 5% ¼W	24312-861
R18	Carb 390Ω 5% ¼W	24312-865
R19	Carb 75kΩ 5% ¼W	24312-932
R20	Carb 560Ω 5% ¼W	24312-872
R21	Carb 110kΩ 5% ¼W	24312-936
R22	Carb 820Ω 5% ¼W	24312-878
R23	Carb 160kΩ 5% ¼W	24312-940
R24	Carb 1kΩ 5% ¼W	24312-880
R25	Carb 200kΩ 5% ¼W	24312-942
R26	Carb 1.5kΩ 5% ¼W	24312-884
R27	Carb 300kΩ 5% ¼W	24312-947
R28	Carb 1.8kΩ 5% ¼W	24312-886
R29 †	Carb 330kΩ 5% ¼W	24312-948
R30	Carb 3kΩ 5% ½W	24313-893
R31 †	Carb 390kΩ 5% ¼W	24312-950
R32	Carb 820Ω 5% ¼W	24312-878
R33 †	Carb 510kΩ 5% ¼W	24312-954
R34	Carb 270kΩ 5% ¼W	24312-946
R35	Carb 4.7MΩ 10% ¼W	24322-982
R36	Carb 62kΩ 5% ¼W	24312-930
R37	Carb 5.1kΩ 5% ¼W	24312-902
R38	Carb 82kΩ 5% ¼W	24312-933
R39	Carb 18kΩ 5% ¼W	24312-916
R40	Carb 10kΩ 5% ¼W	24312-910
R41	Carb 430kΩ 5% ¼W	24312-951

Circuit reference	Description	M.I. code
RV1	WW 2.5kΩ 1% 3W lin.	44371-241
RV2	WW 1kΩ 10% 1W lin.	25815-115
RV3	WW 1kΩ 10% 1W lin.	25811-019
RV4	WW 10kΩ 10% 1W lin.	25815-134
RV5	WW 1kΩ 10% 1W lin.	25811-019
RV6	Carb 22kΩ 20% ¼W lin.	25611-080
RV7	WW 5kΩ 1% 3W lin.	44371-240
RV8	WW 1.5kΩ 10% 1W lin.	25811-020
RV9	WW 100Ω 10% 1W lin.	25811-013
RV10	WW 1kΩ 10% 1W lin.	25811-019
RV11	Carb 220kΩ 20% ¼W lin	25611-086
RV12	Carb 220kΩ 20% ¼W lin.	25611-086
RV13	Carb 100kΩ 20% ¼W lin.	25611-084
RV14	Carb 1MΩ 20% ¼W lin.	25611-090
RV15	Carb 220kΩ 20% ¼W lin.	25611-086
SA	Sweep width wide - narrow	23462-252
SB	Sweep linear - semi-log	23462-252
VT1	BC107	28455-437
VT2	BC107	28455-437
VT3	2N1893	28458-255
VT4	2N1893	28458-255
VT5	BFW43	28438-426
VT6	BFW43	28438-426
VT7	SFT187	28458-334

Unit (34) wide band amplifier

When ordering, prefix circuit reference with 34

C1	Cer 6.8pF ±0.25pF 750V	26324-706
C2	Cer 6.8pF ±0.25pF 750V	26324-706
C3	Cer 6.8pF ±0.25pF 750V	26324-706
C4	Cer 6.8pF ±0.25pF 750V	26324-706

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C5	Cer 6.8pF ±0.25pF 750V	26324-706
C6	Cer 0.001μF +40-20% 500V	26383-242
C7	Cer 0.001μF +40-20% 500V	26383-242
C8	Cer 22pF ±0.25pF 750V	26324-715
C9	Cer 0.001μF +40-20% 500V	26383-242
C10	Cer 22pF ±0.25pF 750V	26324-715
C11	Cer 6.8pF ±0.25pF 750V	26324-706
C12	Cer 0.01μF +80-20% 100V	26383-055
C13	Cer 0.001μF +40-20% 500V	26383-242
C14	Cer 6.8pF ±0.25pF 750V	26324-706
C15	Cer 22pF ±0.25pF 750V	26324-715
C16	Cer 0.001μF +40-20% 500V	26383-242
C17	Paper 0.5μF 10% 150V	26174-179
C18	Plas 390pF 2% 125V	26516-387
C19	Cer 0.1μF +50-25% 30V	26383-031
C20	Cer 0.01μF +80-20% 100V	26383-055
C21	Cer ∅ 500pF 25% 500V	26373-609
C22	Cer ∅ 500pF 25% 500V	26373-609
C23	Cer ∅ 500pF 25% 500V	26373-609
C24	Cer ∅ 0.0047μF +80-20% 500V	26373-665
C25	Cer ∅ 0.001μF +80-20% 500V	26373-714
C26	Cer ∅ 500pF 25% 500V	26373-609
C27	Cer ∅ 500pF 25% 500V	26373-609
C28	Cer ∅ 0.0047μF +80-20% 500V	26373-665
C29	Cer ∅ 500pF 25% 500V	26373-609
C31	Cer 10pF ±0.25pF 750V	26324-709
L1	Special	15110-226
L2	Inductor	35124-134
L3	Inductor	35124-134
L4	10μH 10%	23642-555
L5	0.22μH 10%	23642-545
L6	Inductor	35124-134
R1	Carb 10kΩ 10% ¼W	24341-310
R2	Carb 4.7kΩ 10% ¼W	24341-300
R3	Carb 330Ω 10% ¼W	24341-263
R4	Carb 470Ω 10% ¼W	24341-269
R5	Carb 10Ω 10% ¼W	24341-220
R6	Carb 10Ω 10% ¼W	24341-220
R7	Carb 47Ω 10% ¼W	24341-237
R8	Carb 10kΩ 10% ¼W	24341-310
R9	Carb 4.7kΩ 10% ¼W	24341-300
R10	Carb 470Ω 10% ¼W	24341-269
R11	Carb 100Ω 10% ¼W	24341-250
R12	Carb 390Ω 10% ¼W	24341-265
R13	Carb 10Ω 10% ¼W	24341-220
R14	Carb 6.8kΩ 10% ¼W	24341-306
R15	Carb 2.2kΩ 10% ¼W	24341-288
R16	Carb 560Ω 10% ¼W	24341-272
R17	Carb 10Ω 10% ¼W	24341-220
R18	Carb 330Ω 10% ¼W	24341-263
R19	Carb 150Ω 10% ¼W	24341-254
R20	Carb 47Ω 10% ¼W	24341-237
R21	Met 3.3kΩ 7% ⅜W	24552-094
R22	Met 10kΩ 7% ⅜W	24552-110
R23	Carb 1.2kΩ 10% ¼W	24341-282
R25	Carb 10Ω 10% ¼W	24341-220
R26	WW 270Ω 5% 1½W	25123-061
R28	Carb 10Ω 10% ¼W	24341-220
R29	Carb 1.2kΩ 10% ½W	24341-282
RV1	Carb 500Ω 20% 0.4W	25541-315
T1	Transformer	44221-810
VT1	BFY90	28452-157
VT2	BFY90	28452-157
VT3	BFY90	28452-157
VT4	BFY90	28452-157
VT5	BFY90	28452-157

For symbols and abbreviations see introduction to this chapter

Unit (35) marker mixer and a.l.c. detector

When ordering, prefix circuit reference with 35

Circuit reference	Description	M.I. code
	Complete board	44823-129
C1	Cer 4.7pF ±0.25pF 750V	26324-017
C2	Cer 3.3pF ±0.25pF 750V	26324-014
C3	Cer 3.3pF ±0.25pF 750V	26324-014
C4	Cer 6.8pF ±0.25pF 750V	26324-706
C5	Cer 100pF 2% 750V	26324-897
C6	Cer 6.8pF ±0.25pF 750V	26324-706
C7	Cer 6.8pF ±0.25pF 750V	26324-706
C8	Cer 1pF ±0.25pF 750V	26324-005
C9	Cer 8.2pF ±0.25pF 750V	26324-708
C10	Cer 22pF ±0.25pF 750V	26324-715
C11	Cer 22pF ±0.25pF 750V	26324-715
C12	Cer 10pF ±0.25pF 750V	26324-709
C13	Cer 22pF ±0.25pF 750V	26324-715
C14	Cer 2.2pF ±0.25pF 750V	26324-011
C15	Cer 2.2pF ±0.25pF 750V	26324-011
C16	Cer 4.7pF ±0.25pF 750V	26324-017
L1	Inductor	35124-134
L2	Inductor	35124-134
L3	Inductor	35124-137
L4	Inductor	35124-134
L5	Inductor	35124-134
L6	Inductor	35124-138
MR1	CG91AH	28321-311
MR2	1N82A	28346-114
MR3	HG5004	28332-465
MR4	HG5004	28332-465
R1	Carb 15kΩ 10% ¼W	24341-314
R2	Met 50Ω 1% 1/8W	24616-321
R3	Carb 220Ω 10% ¼W	24341-258
R4	Carb 1kΩ 10% ¼W	24341-280
R5	Carb 470Ω 10% ¼W	24341-269
R6	Carb 470Ω 10% ¼W	24341-269
R7	Carb 1kΩ 10% ¼W	24341-280
R8	Carb 4.7kΩ 10% ¼W	24341-300
R9	Not used	
R10	Carb 220Ω 10% ¼W	24341-258
RV1	Carb 100Ω 20% 0.4W	25541-308

Unit (36) fixed oscillator

When ordering, prefix circuit reference with 36

Circuit reference	Description	M.I. code
	Complete board	44821-701
C1	Cer 4.7pF ±0.25pF 750V	26324-017
C2	Variable 0.6pF - 5pF	26845-151
C5	Cer ∅ 56pF 20% 500V	26373-855
L1	Inductor	35124-420
R3	Carb 2.7kΩ 10% ¼W	24341-292
R4	Carb 2.7kΩ 10% ¼W	24341-292
R5	WW 470Ω 5% 1½W	25123-067
T1	Inductance of C2 and external wire	
VT2	2N3866	28453-867

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
Unit (37) swept oscillator		
When ordering, prefix circuit reference with 37		
Complete board		44823-007
C1	Cer 22pF 10% 250V	26343-707
C2	Cer 3.3pF ±0.25pF 750V	26324-014
C3	Cer 22pF 10% 250V	26343-707
C4	Cer 1.5pF ±0.25pF 750V	26324-008
C5	Cer ∅ 500pF 25% 500V	26373-609
C6	Cer ∅ 12pF 20% 500V	26333-151
C7	Cer ∅ 0.0047μF +80-20% 500V	26373-665
L1	Inductor	35124-419
L2	Inductor	35124-134
MR1	1N5139	28381-476
R1	Carb 1.2kΩ 10% ¼W	24341-282
R2	Carb 2.7kΩ 10% ¼W	24341-292
R3	Carb 100kΩ 10% ¼W	24341-335
R4	Carb 100kΩ 10% ¼W	24341-335
R5	WW 270Ω 5% 1½W	25123-061
R6	Carb 22Ω 10% ¼W	24341-228
VT1	2N3866	28453-867

Unit (38) level control and mixer

When ordering, prefix circuit reference with 38

Complete board		44823-118
C1	Cer 1.5pF ±0.25pF 750V	26324-008
C2	Cer 1.5pF ±0.25pF 750V	26324-008
C3	Fabricated	
C4	Fabricated	
C5	Cer 2.2pF ±0.25pF 750V	26324-011
C6	Fabricated	
C7	Fabricated	
C8	Fabricated	
C9	Cer ∅ 56pF 20% 500V	26373-855
L1	Length of steel rod	
L2	Inductor	35124-134
L3	Length of steel rod	
MR1	HG5004	28332-465
MR2	HG5004	28332-465
MR3	HG5004	28332-465
MR4	TIV305	28349-001
MR5	TIV305	28349-001
R1	Carb 470Ω 10% ¼W	24341-269
R2	Carb 390Ω 10% ¼W	24341-265
R3	Carb 33Ω 10% ¼W	24341-233
R4	Carb 100Ω 10% ¼W	24341-250
R5	Carb 1kΩ 10% ¼W	24341-280
SKT1	Type S, GE65006	23443-889

Unit (40) chassis and front panel

When ordering, prefix circuit reference with 40

C1	Cer 0.01μF +80-20% 100V	26383-055

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
PL1	24-pin	23435-610
R1	Carb 3.3kΩ 5% ¼W	24312-894
R2	Carb 15kΩ 5% ¼W	24312-914
RV1	Carb 10kΩ + 10kΩ 20% 1/8W log.	25672-322
RV2	WW 1kΩ + 5kΩ 10% 1W	25882-101
SA	Marker function	44325-114
SB	Pulse - birdie markers	23462-252
SC	Positive - negative markers	23462-252
SD	Continuous - alternate	23462-252
SE	A.L.C. calibrate (on RV2)	25882-101
SKT1	BNC 50Ω coaxial	23443-443
SKT2	BNC 50Ω coaxial	23443-443
SKT3	Type N, GE15041	23443-766
X1	Ferrite bead	

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors: No suffix = microfarads, p = picofarads.
† value selected during test, nominal value shown.

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers.

3. SYMBOLS

arrow indicates clockwise rotation of knob.

RANGE etc., external front or rear panel marking.

preset control.

(31) unit identification number.

point marked with this symbol is connected to and receives power from

point marked with this symbol

These symbols are used to identify branches of the power supply circuitry but have no particular physical reality on the printed boards.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form.
See also introduction to Chapter 6.

5. SWITCHES

Rotary switches are drawn schematically.
Letters indicate control knob settings.
1F = 1st section (front panel), front
1B = 1st section, back
2F = 2nd section, front
etc.

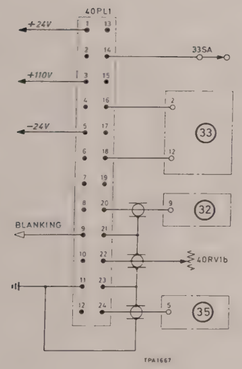


Fig. 7.1 40PL1, connections to main unit

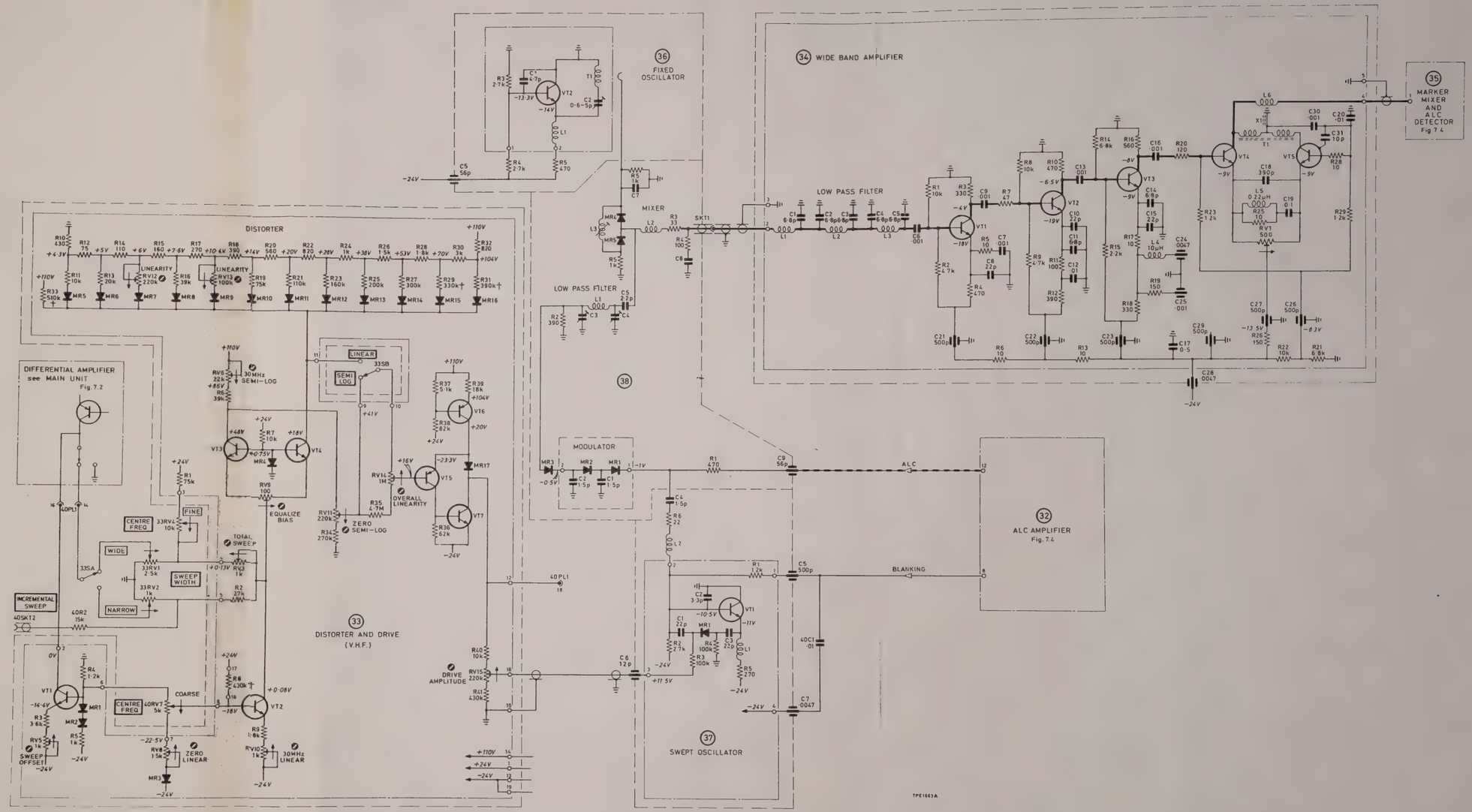


Fig. 7.2 Drive, oscillators and wideband amplifier

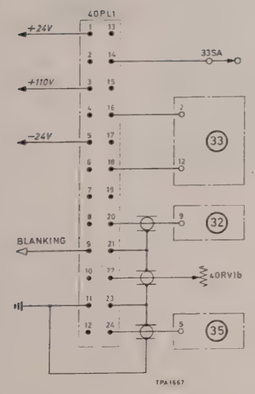


Fig. 7.3 40PL1, connections to main unit

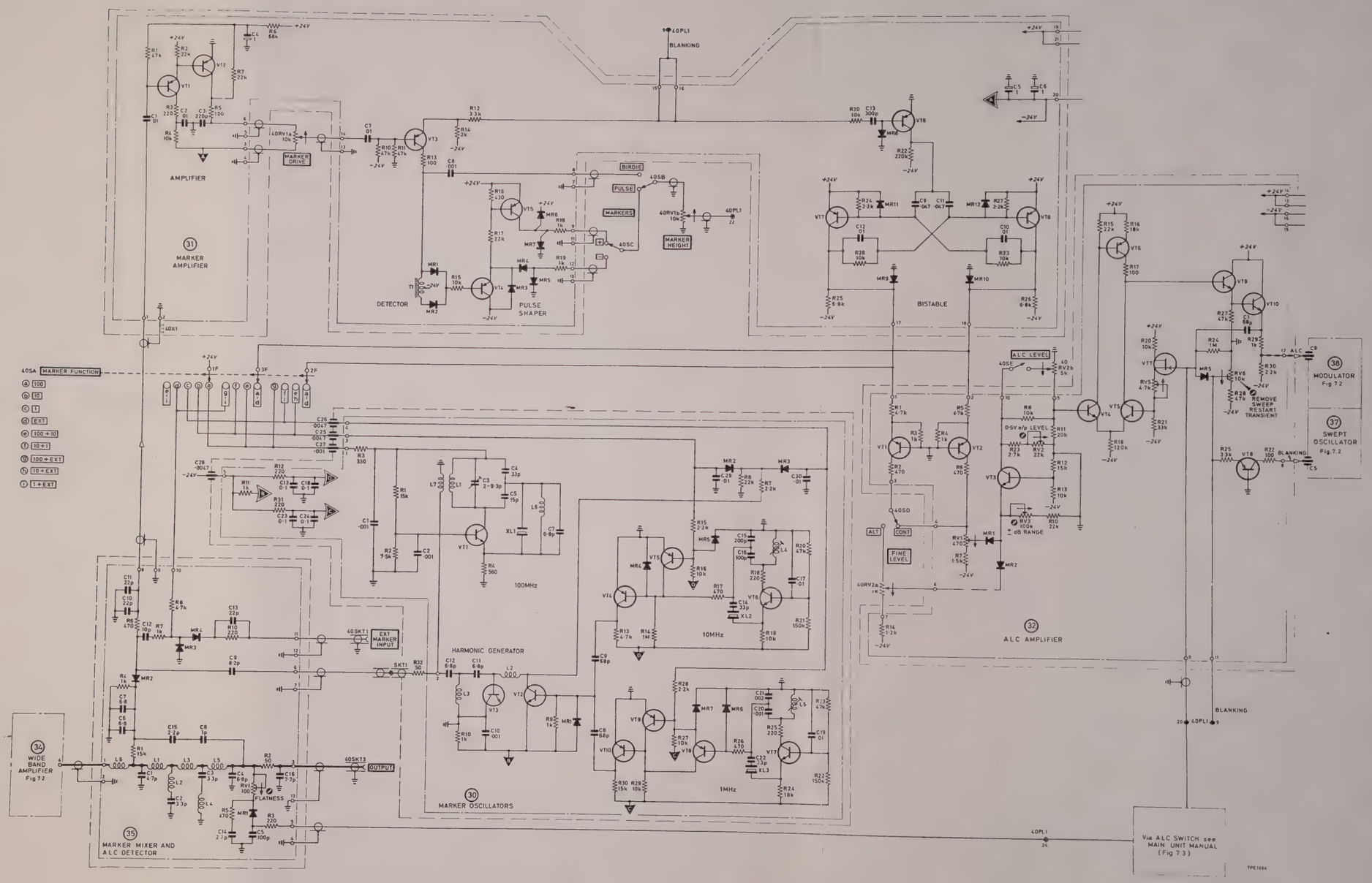
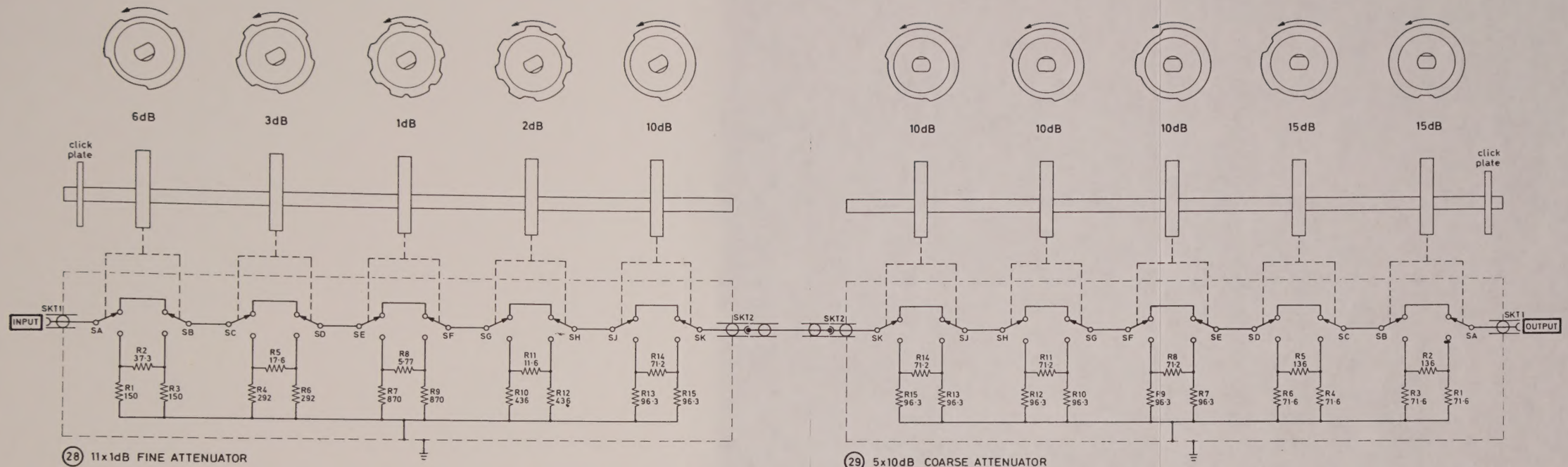


Fig. 7.4 A.L.C. and markers



(28) 11x1dB FINE ATTENUATOR

(29) 5x10dB COARSE ATTENUATOR

TPE1632

0	1	2	3	4	5	6	7	8	9	10	11	ATTENUATION dB	50	40	30	20	10	0
												PAD SECTIONS IN CIRCUIT						
												dB dB						
—	⊓	—	—	⊓	—	—	⊓	—	—	—	⊓	1 10	⊓	⊓	⊓	⊓	⊓	—
—	—	⊓	—	—	⊓	—	—	⊓	—	—	—	2 10	⊓	—	⊓	⊓	—	—
—	—	—	⊓	⊓	⊓	—	—	—	⊓	—	—	3 10	—	—	⊓	—	—	—
—	—	—	—	—	—	⊓	⊓	⊓	⊓	—	—	6 15	⊓	⊓	—	—	—	—
—	—	—	—	—	—	—	—	—	—	⊓	⊓	10 15	⊓	⊓	—	—	—	—

Fig 7.5 Attenuators, TM 9695

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